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EDITORIAL NOTES.

THE possibility of coaling steamers at sea seems likely to be one of the realizations of the near future. Very successful experiments have recently been conducted both by the British Admiralty and the Navy Department of this country. In both cases it is reported that the work was successfully accomplished, though modifications in the mechanisms employed have been suggested. When the work can be done the effectiveness of cruisers and of a blockading squadron will of course be very greatly increased, and the range of sea covered be correspondingly widened.

ONE of the notable events in army circles promised for the near future is the test of the rapid-fire 6-pounder and 4.7 in. caliber rifles at Sandy Hook. Arrangements have been made to hold these trials at some time during the present month; but when we take into consideration the fact that the guns were on exhibition at Chicago up to the closing of the Fair, and that they must then be packed and shipped to Sandy Hook, it is not at all probable, although it is possible, that any work will be done before December 1. However, the trial is not far distant, and when it does come off we may look for some astonishing results in the effectiveness of the weapons that have been offered for the competition.

A PROPOSITION has been made with the view of increasing the efficiency of our weather bureau by the establishment of a telegraphic or telephonic communication with the various lightships that are anchored off the coast. Thus, were such a communication to be established between the shore and the Nantucket lightship, it would be possible to obtain news of incoming European steamers several hours earlier than is possible under the present system, besides enabling the ship to signal the approach of storms to passing vessels, which are now wholly without such warning. This naturally has suggested the mooring of vessels along the transatlantic track, which naturally appears impracticable, whereas the establishment of communication between the lightships and the shore seems to be entirely within the bounds of practicability, and the results obtained would certainly be of the highest value.

A REFERENCE to our list of accidents to locomotive engineers and firemen for the month of September shows an increase in the number of collisions over that of preceding months, which suggests the advisability of a better system of signaling than that which obtains on most roads, as well as an improvement in the training and discipline of the train crews. Where the traffic and the finances of the company will not warrant the installation of an interlocking system of block signals, there should be a rigid insistence on the careful execution of the rules regarding the duties of the rear flagman and the switchman. It is inexcusable that a switchman should open a switch in the face of an express train, as was done in the case of one of the accidents in the list referred to.

THE success which seems about to crown the efforts of the Navy Department in securing a practical submarine torpedo boat has set a host of inventors busy in devising schemes for submarine navigation. One, with a boldness deserving of a nearer probability of success, has even gone so far as to propose a submarine electric trolley line for transatlantic service. Thus in one fell swoop he breaks the record of the time of the passage, removes the horrors of seasickness and realizes the machine of Captain Nemo. Of course the details of the work have not yet been developed, but a New York daily has given the scheme publicity, and the mere matter of detail is a trifle beside the conception. We do not like to promise our readers that a full description of the methods to be employed are to be forthcoming at once, but we will watch for them with a deal of interest.

A STRANGE oversight has occurred in the designs of some of the vessels recently designed for lake service. In the desire to secure the greatest possible cargo-carrying capacity, the depth over the sill of the Ste. Marie Canal and the breadth of the lock has apparently been the only point considered. The new vessel, the *Centurion*, illustrated in this Journal in April, 1893, is 379 ft. long, and has a capacity of 155,000 bushels of grain, yet the limitations of river navigation have been overlooked, and on a recent trip to Chicago a number of piles had to be pulled in the Chicago River in order to get her to the dock. There is no good reason apparent why any size of vessel that can be floated should not be navigated through the lakes; but until changes are made in the harbor facilities of such ports as Chicago and Cleveland, the growth of lake freighters will probably be at a standstill.

DETENTIONS ON RAILROADS FROM DEFECTS IN LOCOMOTIVES.

IN these days of frequent and appalling railroad accidents, any earnest and rational effort to indicate the primary causes to which they are due should receive more than ordinary attention. Hardly a day passes now without an account of one or more accidents in the daily papers, the horrible details of which must make every sensitive reader shudder. While we are boasting over the magnificence of our great Exhibition, disasters are occurring on our railroads which are spreading mourning through the land, and are sufficient to excite the indignation of the whole people, and should drive some of our railroad managers into the ashes and sackcloth of humiliation.

On another page a table will be found which gives the statistics of the defects in locomotives which have caused detentions on one of our prominent roads. For the present the name of the road will not be made public, the immediate purpose being to call out similar records from other roads for purposes of

comparison and comment. The road from which our record has been obtained is not an easy one to operate, and its topography would not lead one to expect an exceptionally low rate for locomotive failures. The road has nearly a thousand locomotives, many of them over 20 years old.

If a record of this kind could be supplemented with full data and sketches showing the character of the failures, with dimensions of the parts and full particulars of each, it would add very much to the value of the record, and would be extremely instructive. We are in hopes that the publication of the table may induce some one at some future time to supply such further data as we have indicated. Records of this kind have been kept on some roads. Their publication would be a public benefit. With the mere figures of the number of failures before us comment must, to a very great extent, be blind. Nevertheless, the mere numerical data are significant in many cases.

The most prolific cause of detention, it will be seen, is due to the failure of the springs and their attachments, such accidents amounting to nearly 15 per cent of all; the breaking of spring hangers and bolts alone amounting to nearly 10 per cent. With complete data of the nature of these failures and knowledge of the construction of the engines on the road, it ought to be possible to show the design, construction, and proportions of the parts which are most subject to failure. The moral of the investigation would be to abandon and avoid the forms, proportions, and designs of those parts which fail most frequently.

We confess to some surprise to see that the second most prolific cause of detention was due to failures of grate arrangements. One feels about this part of the report as the woman did who asked a man with only one leg how he lost the other, and was told "it was bit off." We have a consuming desire to know how the grates failed. Was it due to the burning of the bars or to the mechanism by which they are supported and operated?

Another surprise attends the figures showing the detentions from the failure of eccentric straps and rods, which sum up to a total of 115. The failure of eccentric bolts—which, we take it, means eccentric strap bolts, although it may be the bolts by which the rods are attached to the straps—amounts to 57. This would seem to indicate insufficient strength in these parts. The breaking of rods and straps is often due to neglect in oiling, and probably the bolts fail at times from the same cause. If this neglect is the principal cause, it would seem to be a strong argument in favor of some form of valve gear outside of the engine, where it would be more accessible for oiling and examination than eccentrics are which are inside.

The next most prolific cause of detention is the breaking of cross-head gibs and bolts, to which 66 cases are assigned. This report also excites one's curiosity to know what kind of gibs and bolts failed, and how. Are the failures due to defective design or construction or to imperfect lubrication? The cure for the evil must depend upon the cause to which it should be assigned.

Fifty-nine detentions were caused by the breaking of main connecting-rods or their parts; 36 of these were due to the failure of straps—the moral of which would seem to be to abandon their use. The fracture of gibs, keys and strap bolts is charged with 19 detentions. Only 4 main rods broke.

Defects in side or coupling-rods and their attachments caused 30 detentions, their straps and bolts being again responsible for much the greater part of the breakages. This emphasizes the importance of abandoning the use of straps. The comparatively small number of breakages of coupling-rods, only 7, may be noted. Probably a much larger number of fractures of coupling-rods in proportion to the breakage of main connecting-rods would have been anticipated.

Forty-one piston-rods broke, which seems to indicate that they should be made larger; but an investigation and test of the strength of the material of those which failed would throw some light on the cause.

The failure of air pumps to work is charged with 53 detentions. This seems to indicate that there is room for improvement in the design of these machines. If their construction was open to free competition, as it probably will be before long, the process of evolution would be likely to produce a machine less liable to fail. Considering how short a time air pumps have been used on locomotives, it is perhaps not remarkable that they have not yet reached complete perfection.

It will be seen that 37 steam chests burst, which suggests the question whether a stronger form could not be designed. The weakness of a cubical-shaped vessel for resisting internal pressure is obvious. Cross stays are impracticable in a steam chest, so that the flat sides and top must be strengthened with ribs to resist the strains to which they are subjected. Cylindrical steam chests for piston valves have, in this respect, an advantage. If the practice were not so common, it would seem like very bad engineering to make a box with flat sides to resist the internal pressure which steam chests must often stand. The design of a new or improved form for these vessels, better adapted to its purpose than those which are now so generally used, is an interesting problem for some of our ingenious designers to study over.

Thirty-eight piston-rod glands and studs for same broke. This was due doubtless to improper screwing up of the bolts. If an engineer finds that his packing leaks, his first impulse is to screw up the bolts. If the leak is not stopped, he screws them up a little more, and may repeat this several times, with perhaps an accompaniment of language not proper to print here, at the same time forgetting, or not stopping to inquire, whether the packing has been in use so long as to be solidified to a degree equaling that of wood or stone. The bolts are unduly strained or the gland "canted," and a break naturally follows. The use of metallic packing seems to be the remedy.

Twenty-nine driving axles broke. It is not said how long they are allowed to remain in service before being removed; 22 driving boxes and 21 springs also failed. The latter, if added to the failure of spring hangers, etc., makes these parts by far the most frequent source of detention, and naturally leads to an inquiry whether improvement is not in some way possible. Students of English rolling stock must have noticed that, notwithstanding the average condition of their roads is better than ours, the general practice there is to use longer springs than we do. May it not be, in view of the record before us, that it would be well for us to follow their practice in this respect?

Only 4 engine truck axles are reported as broken; but again the untrustworthy springs are credited with 12 detentions. These, with 3 failures of tender springs, make a total of 221 detentions, or nearly 17½ per cent. of all were due to the breakage of the carrying springs or their attachments.

Engine frames seem to stand the wear and tear better than would be expected when their size, the importance of the functions they must perform, and the strains to which they are subjected are taken into consideration, as there were only 24 breakages.

If we leave the eccentrics, their straps and rods out of consideration, it is surprising how seldom the valve gear gives out. It is charged with 4 broken lifting shafts, 1 link, 2 hangers, 4 valves, 5 valve stems, and 9 valve yokes—25 failures in all.

Piston packing rings are charged with 13 failures, piston heads with 8 and piston keys with 15, or 36 in all.

Twelve pulling bars and bolts broke, which would seem to indicate insufficient strength.

Fourteen rocker arms and 1 rocker bolt failed, which some

of our English friends may quote against us, although, as a general thing, there is no working part of a locomotive which costs so little to maintain as a rocker.

Of the small number of tender truck axles broken, only 3 will be noted, and only 7 detentions were caused by broken or loose engine tires.

It should be said that, as we understand it, the breakages recorded in our table do not show all those which occurred on the road, but only those which caused detentions. Our comments are intended to direct attention to those features in locomotive construction which seem to need improvement most. The record seems to be a remarkably good one, and if we were able to compare it with similar records from other roads, which we invite, the comparison would be very instructive.

ASPIRING MERIT.

To most people possessed with the right kinds of heads and hearts, it is always a satisfaction to recognize and aid those who are ambitious, but unknown. We are in receipt of a communication from a rural post-office which seems to give us such an opportunity. Our correspondent says:

"I am looking for a situation at working for and traveling with some surveying or photographing party, or party who is locating new carriage roads or railroads, especially among picturesque natural scenery, where it would be good views for photographing, etc., and I claim to have the following points:

"1. I can prove that I am strictly honest in every respect.

"2. I am very ingenious in mechanical and machine work, and an inventor.

"3. I have had a great deal of experience in camp-life, carrying, moving, building camps of various kinds, and know just what is required in a camp (except cooking—that I do not know much about), but I do know what groceries, provisions, bedding, tinware, hardware, clothing, tools, implements, boat fixtures, carrying apparatus, etc., is needed in camping and traveling far away from civilization, as I have traveled all over the Adirondack wilderness during six years, and visited over 300 of its lakes and over 400 of its mountain peaks, which you can judge requires a great deal of climbing over, through, around, under, up, down, into, along, across, onto, between, and by the side of a great many ledges, swamps, windslashes, burnt timber, underbrush, wet places, streams, cataracts, rapids, ponds, lakes, beaver meadows, still waters, hills, ravines, mountains, slides, rocks, thickets, berry brush, sand, plains, mossy and wet hard head-stones, mud quicksands, shelving rocks, ledges, etc., fallen timber, alders overflows, all of which makes me good at locating roads, canals, bridges, paths, etc., among such places, when combined with the great taste I have for such work and of locating them where they will run in view of the most picturesque natural scenery possible, as that is a good thing, especially on a toll road or railroad, to attract travel. There is nobody likes picturesque natural scenery more than I do.

"4. I am first-class at repairing any mechanical object that needs it.

"5. I am tough and healthy, and am not afraid of catching cold by sleeping out-doors or wading water or traveling at any time of the year (but prefer a mild climate in winter, such as California, Oregon, Washington, Nevada, Idaho, Montana, Wyoming, Colorado, New Mexico, Arizona, Texas, North Carolina, Tennessee, Kentucky, Virginia, West Virginia, etc.).

"6. I am good at keeping accounts, figures, etc., good memory, prompt in correspondence, systematic in doing business, etc. (which is more than you can say of most men). Age, 31.

"7. I can give hundreds of the best of references to prove all this."

This statement of his qualifications is followed by about two pages of references, and our unrecognized genius says he can give hundreds of others, and adds, "They, of course, do not know all my good talents, knowledge, and taste for the work I ask for, but are *acquainted by sight at least.*"

He gives his ideas of the proper way to locate roads, and they—the ideas—are—and doubtless the roads would be—good.

To show the probity of the applicant for employment, he says, "I enclose two stamps for a reply." The stamps were there.

By reading between the lines there are indications of clear grit and sterling character in our correspondent's entertaining letter, and we will take pleasure in giving his address to any one in need of such services as he is anxious to render.—EDITOR AMERICAN ENGINEER.

NEW PUBLICATIONS.

THE NEBRASKA CITY BRIDGE. *A Report to Charles E. Perkins, President of the Chicago, Burlington & Quincy Railroad Company.* By George S. Morison, Chief Engineer of the Nebraska City Bridge. (13¾ × 21¼ in., 68 pp.)

This is the latest of Mr. Morison's splendid reports, for which he has become famous. It begins with a photogravure showing an excellent view of the bridge. This is followed by a preliminary narrative, a general descriptive table showing the cost of the pneumatic foundations, masonry and piers. A description is then given of the superstructure, the weight of materials used, the date of erection and cost. Similar data are given with reference to the approaches and protection work and the cost of the whole structure, which was $582,790.87, to which $18,346.12 more was added for the highway accommodations. A list of engineers, employés, and contractors, and the act of Congress authorizing the construction of the bridge, and the contract with the War Department are given in an appendix. Other appendices contain, Specifications for Masonry, Records of Sinking Caissons, Time, Cost, and Materials Used in Foundations, Specifications for the Superstructure, and Records of Tests of Steel Bars.

The succeeding engravings consist of an excellent full-page map showing the location of the bridge; a general elevation, plan, profile and alignment; views of the abutments, and another page showing the piers, a diagram showing the rate of progress in sinking caissons, and another which is a record of water stage in the river during the erection of the bridge; 12 full-page photo-lithographs of details of the bridge, and two full-page strain sheets.

The paper, press-work, typography, printing, drawing, and engraving leave nothing to a reviewer to suggest, criticise, or desire. It is a very valuable record of an important work.

TRANSPORTATION. Vol. I, No. 1.

"We old fellows," who have been grinding in the editorial mill for, lo! these many years, do not cease to wonder at the courage and temerity of younger and less-experienced men who launch new vessels into a stream already crowded with various kinds of craft, some of which, if current report be true, have difficulty in keeping afloat. "But hope springs eternal," etc. It thus happens that Mr. William Morris Hayes, Conductor, Editor and Publisher, and H. W. Spofford, his assistant, of New York, have concluded, as they say in their announcement, that "with all the journals now published devoted individually to the special subjects covered by *Transportation*, the field is not fully occupied." Those of us who have borne the burden and heat of these many days cannot read this without ejaculating, if it is not now fully occupied, then "Good Lord, have mercy on us!"

It is ungracious, though, not to welcome new-comers; therefore we extend the hand of journalistic fellowship to *Transportation*. Its editors have engaged in a great calling, in which either a splendid success or miserable failure are possible. It is a road in which fortune and salvation can be achieved, or which may lead to poverty and the damnation of the souls of the editors. Perhaps at the outset of their careers a little patriarchal advice to the conductors of a new venture may not be out of place. Advice and small-pox are alike in this, that they are given more willingly than they are received, and the former is unlike deeds of charity, in that the blessedness of it consists in the receiving and not in the giving.

There is every reason for thinking that our young aspirants to journalistic fame intend always to speak, and write the truth. Probably, though, they do not realize how strong the temptation will be at times to depart therefrom. They may be assured, though, that unless they adhere strictly to the maxim of a distinguished journalist, "Never to print a paid advertisement as news matter," it will be impossible to maintain their veracity. They may disregard that injunction once, twice, perhaps a dozen times without departing from strict integrity; but they may be assured that if they persist in publishing paid advertisements as editorials or news matter, that sooner or later they will lie like gravestones. The old-fashioned people tell

us that sheol is the ultimate destination of people who are given to this. Whether it is or not should not lessen the significance of the example of Ananias and Sapphira to young editors and old ones as well.

¶ Success in journalism at the present day requires many and diverse qualifications, some of which are not of a very high or ennobling order. We have not time nor room for a disquisition on "the elements of success in technical journalism," although an interesting essay might be written on that subject. We trust, though, that our new contemporary may deserve and have success. It may not be amiss to remind them though of the ill effects of mixing beverages, and to advise them not to allow their advertising columns and editorial pages to commingle, the moral effects of which are worse than those of mixed drinks. Read the ten commandments occasionally, and then "hustle."

THE LAW OF INCORPORATED COMPANIES OPERATING UNDER MUNICIPAL FRANCHISES, SUCH AS ILLUMINATING GAS COMPANIES, FUEL GAS COMPANIES, ELECTRIC CENTRAL STATION COMPANIES, TELEPHONE COMPANIES, STREET RAILWAY COMPANIES, WATER COMPANIES, ETC. By Allen Ripley Foote and Charles E. Everett. Robert Clarke & Company, Cincinnati.

The authors of this work have undertaken, with the aid of a co-editor in each State, to present a short historical sketch and an outline of the laws of each State relating to corporations operating under municipal franchises, special attention being given to the kinds of corporations enumerated in the explanatory portion of the title. The important changes in the constitutional, legislative, and judicial policies of the various States toward such companies is traced in brief, and the main provisions of the laws now governing and regulating the organization and operation of such corporations presented. The names of the co-editors include not a few well-known lawyers, and the several compilations appear to have been well made.

This portion of the work is evidently intended as a handbook for lawyers, and also for municipal officers and other laymen who may have to deal with the subject. Good lawyers will, of course, use it as they use all text-books, only for suggestions of general principles and for references to the original, constitutional, and legislative provisions and judicial decisions, and for these purposes will find it of value. It will, however, be particularly interesting and valuable to laymen who do not have access to the original sources. When they wish to go to the latter or to determine nice questions of law in reference to municipal franchises, they will still be compelled to consult lawyers.

These historical sketches and compilations of the laws of the several States are preceded by a discussion by Mr. Foote of the economic principles involved in the operation, control, and service of such companies. The author says of his purpose in this discussion, "I have sought to elucidate principles and clearly to define strategic points in order to measure by fundamental rules the progress made by the several States in aligning legislation with the requirements of such rules. My purpose has been to outline the subject in a way to induce others to engage in an exhaustive discussion of the fundamental principles upon which municipal, political, and industrial corporations must be founded, if citizens of municipalities are to enjoy the greatest obtainable advantages from the use of modern municipal conveniences. . . . No general question of governmental policy occupies at this time so prominent a place in the thoughts of the people as that of properly controlling without unnecessarily checking the growth of corporate power."

Thoughtful readers will differ widely from each other in their views of the success of the author in accomplishing his very laudable undertaking. There is, however, much in this discussion which our mayors and aldermen and embryonic statesmen, and even an occasional United States Senator, might ponder with profit. For example, there are some good old doctrines relating to labor and property set forth by the author in Chapter IV of the treatise with great clearness and force. "The freedom of labor is inseparable from the freedom of contract;" "A contract that binds one party to pay a certain consideration as the full price of labor performed, binds the other party to accept such payment in full for service rendered;" "By assuming the risk of loss, the right to own the profit is secured;" "The consideration for which an employer guarantees the wages of labor is the expected profit;" "The consideration for which a man accepts wages is the means of present support and immunity from risk of loss," are a few of the doctrines which are worthy of being carefully kept in mind by all classes.

DER BRÜCKENBAU. *Ein Handbuch zum Gebrauche beim Entwerfen von Brücken in Eisen, Holz und Stein, sowie beim Unterrichte an Technischen Lehranstalten.* (Bridge Construction: A Manual for use in Designing Iron, Wooden, and Stone Bridges, and also for Instruction in Technical Schools.) By E. Häseler, Professor in the Technical High School at Brunswick. Volume I, Parts I and II. Octavo, paper, 239 pp., and 37 plates. Brunswick: F. Vieweg & Son, 1888 and 1893.

This work is to consist of three volumes, the first on iron, the second on wooden, and the third on stone bridges. It is not stated whether or not the two parts before us constitute the whole of the first volume, but with the exception of joints and lateral bracings they cover the subject of common truss bridges in a fairly complete manner. The six chapters treat of the following topics: General Arrangement and Main Parts of Trusses, Quality of Material and Allowable Stresses, Rivets and Bolts, Cross-sections for Chords and Webbing, Bed-plates and Rollers, Roadway and Sidewalks. In Part I the presentation may be called descriptive and practical, although the theoretical and empirical formulas for obtaining dimensions are usually given. The chapter on the roadway and floor system, however, contains lengthy theoretical investigations regarding the flexure of buckle and corrugated plates. It was in order to perfect these investigations that the publication of Part II was delayed so long as five years after that of Part I. The efforts of the author during this period to deduce satisfactory formulas for buckle plates have not been rewarded with success, on account, he says, of the imperfect state of the science of the strength of materials. Nothing but comprehensive tests will enable this to be done, and such tests must be mainly made within the elastic limit of the material.

The author takes account of shocks and dynamic stresses by using the formulas of Weyrauch and Launhardt, which are based on Wöhler's experiments. For columns Rankine's formula is used, but no comparison is made with the results of tests, and the list of literature given includes none of the many investigations conducted in this country. The chapter on cross-sections for chords and web members, which consists of only 16 pages, might have been greatly extended; eye-bars, indeed, are scarcely considered at all. Bed-plates, rollers and rockers, on the other hand, are given 40 pages, the theoretical discussions predominating. The chapter on roadway systems occupies the whole of Part II (110 pages), and it contains, besides the theoretical investigations already mentioned, many practical details which might advantageously be studied in this country. The weak point in American bridges, as is generally known, is the floor system, and anything which tends toward its improvement is gladly welcomed.

The work of Professor Häseler is probably of that compendious kind, so common in Germany, which requires years in publication, the first parts perhaps passing through several editions before the last ones are issued. The 37 plates of the two parts before us contain 321 cuts of bridge details, all beautifully drawn and every line having its meaning, many of which are likely to be of value to American designers, since the methods of bridge construction on the two sides of the Atlantic are likely to become more and more similar as the prices of iron and labor become more nearly equal.

A PRACTICAL TREATISE ON FOUNDATIONS. *Explaining fully the Principles Involved, with Descriptions of all the most recent Structures, Accompanied by numerous Drawings; also an Accurate Record of the Bearing Resistances of Materials as Determined from the Loads of Actual Structures.* By W. M. Patton, C.E. New York: John Wiley & Sons. (402 pp., 6 in. × 9 in.)

The author of this book, who has had over 18 years of active practice in the construction, and has been a professor of engineering for 6 years, begins his treatise by telling his readers that "in a work on foundations, theories and formulæ are of little value; and therefore but little space is given to the discussion or criticism of either." In the discussion of the theory of arches he says, in confirmation of the view expressed in his preface, that it "is perhaps as little understood as in ages past. Mathematical and mechanical theories, after carrying you through the intricate mazes of higher mathematics, have surely led to no satisfactory or practical results. . . . Mr. Rankine, after going through a most able and wonderfully conceived discussion of this subject, tells you to make your factor-of-safety from 20 to 40, and closes by saying: 'The best course in practice is to assume a depth for the keystone according to an empirical rule, founded on dimensions of good existing examples of bridges.'" This recalls the master mechanic's rule for calculating the counter-weights of a locomotive, "Figger awhile, and then guess at it."

Undoubtedly the value of mathematical calculations is very limited in the design and construction of foundations. The data on which such calculations are based are always uncertain. The author of the book before us has therefore done well to treat his subject almost entirely in an empirical method. His inferences are drawn from experience, and he tells his readers whether the results were satisfactory or otherwise.

The various chapters or articles, as they are called, are on Foundation Beds, Foundations, Concrete, Building Stones, Quarrying, Stereotomy, Masonry, String Courses and Coping, Ice and Wind Pressures, Retaining Walls, Arches, Brick, Box Culverts, Cements and Hydraulic Limes, Mortar, Sand, Stability of Piers, Waterway in Culverts, Arch Culverts, Cost of Work, Definitions and Tables, Timber Foundations, Coffer Dams of Timber, Open Caissons, Cushing Cylinder Piers, Sounding and Borings, Timber Piers, Framed Trestles, Properties of Timber, Durability of Timber, Preservation of Timber, Joints and Fastenings, Trestle Foundations, Timber Piles, Comparative Estimates of Costs of Framed and Pile Trestles, Embankment of Earth on Swamps, Deep and Difficult Foundations, Pneumatic Caissons, Caisson Sinking, Combined Crib and Caisson, All-Iron Piers, Location of Piers, Poetch Freezing Process, Quicksands, Foundations for High Buildings, High Buildings.

All these subjects are treated in a discursive sort of way, the author bringing together a large amount of his own and other engineers' experience in the construction of foundations. Excepting in the discussion of the Theory of Arches, but very little mathematical elucidation is employed. The illustrations are nearly all contained in 22 folded plates at the back end of the book. The defect of these is that their scale is too small. Apparently the drawings were reduced so that they would go on a page of the book. The folded sheets afford ample space for larger illustrations, which would be more satisfactory. A more liberal use of engravings all through the book would, we think, have added to its value. Take as an example the article with the title "Definitions," which contains explanations of the meaning of such terms as skew-back, arch-ring, intrados or soffit, etc. A well-executed illustration showing these parts and their relation to others would have made the whole matter much clearer to the reader, and would have impressed the matter on his mind much more ineffaceably than a mere verbal definition can. From the book it may be inferred that the author, like many other civil engineers, is not a draftsman, and does not think graphically. Altogether it is an excellent book, and has the great merit of lucidity. It is very clearly written, easily understood and practical throughout, and the best book in the language for the student of the subject to which it relates or for a young engineer engaged in that kind of work.

LOCOMOTIVE RUNNING REPAIRS. By L. C. Hitchcock, General Foreman of "Soo Line" Shops. Terre Haute, Ind.: Debs Publishing Company. (108 pp., 4 × 6 in.)

In this little book the author says that it has been his desire "to give," in language as concise as possible, some methods of making running repairs on locomotives, which, from personal observation, he knows to have been productive of good results," and that "the book is more especially calculated to benefit machinist apprentices and those inexperienced in this class of work."

The writer, it is thought, has succeeded admirably in his purpose. It is clearly written and well illustrated, and all the instructions are expressed in language which any apprentice ought to be able to understand. In the different chapters the following subjects are discussed: Grinding in Brass Valves, Cocks, etc.; Rods, Setting up Wedges, Tramming; Springs; Setting Slide Valves; Flange Wear; Shoes and Wedges; Driving Boxes; Washing Boilers; Moving Eccentrics; Back Cylinder Head; Guides; Tire Wear; A Time-Saving Wheel Truck; A Signal Holder.

The author discusses a range of subjects which do not often receive consideration in other books on the locomotive. He explains methods and appliances for doing work, and gives diagrams to show how to proceed, and has that comparatively rare faculty of understanding his subject thoroughly and then of placing himself in the attitude of mind to it which a person who does not understand it must occupy. He does not waste phrases in talking twaddle, but goes directly at his subject, with the evident purpose of inserting his own idea into the head of the fellow he is writing for. Unless that fellow is a blockhead, Mr. Hitchcock will undoubtedly succeed in what he aims to do.

His book is well printed on good paper with limp covers, and is designed to be carried in the pocket. It ought to have a place in the pocket of every apprentice and most of the journeymen in every locomotive shop in the land and out of it.

One adverse criticism we feel bound to make. The book is bound with wire, and the back is held together as though it had been riveted in a hydraulic riveting machine. The inside margin on the pages is narrow, so that they are not easily read. If in another edition the publisher would move the type outward ¼ in., so as to narrow the outside margin that much and widen the inside one, it would be a great improvement.

MANUAL OF IRRIGATION ENGINEERING. By Herbert M. Wilson, C.E. New York: John Wiley & Sons. (351 pp., 5¼ × 9 in.)

This book is intended for irrigation engineers and not for irrigation farmers. It is divided into three parts, which treat of Hydrography, Canal and Canal Works, and Storage Reservoirs. It is illustrated by 29 full-page plates and 100 smaller engravings. The subject is discussed very fully—sometimes it is thought too much so. The author often runs into platitudes and fatuitous observations which are exasperating. Thus, in speaking of the "relation between lands and water supply," the reader is gravely informed that "in designing an irrigation work the first consideration is the land to be irrigated." In speaking of "survey and alignment" it is said: "Having determined the source of water supply and its relation to the irrigable lands, the third question in order of importance is the alignment of the canal;" and again, "In order that the best possible alignment may be obtained, careful preliminary and location surveys are necessary;" and on "obstacles to alignment" it is thought necessary to tell irrigation engineers that "such obstacles as streams, gullies, ravines, unfavorable or low-lying soil or rocky barriers, are frequently encountered in canal alignment." On "curvature" the grave observation is made that "a direct or straight course is the most economical." The writer might as well have added a demonstration that the shortest distance between two points is a straight line.

The book is, however, full of useful information mixed with a good deal of chaff, and will be interesting and useful to all who are concerned with the subject of which it treats and which is of rapidly increasing importance.

BOOKS RECEIVED.

The Rensselaer Polytechnic Institute Handbook of Information. Troy, N. Y.

The Transition Curve by Offsets and by Deflection Angles. By C. L. Crandall, C.E. New York: John Wiley & Sons.

The First Steam Screw Propeller Boats to Navigate the Waters of any Country. By Francis B. Stevens. Reprint from the Stevens *Indicator*.

Objects of Interest to Engineers and Others in and about Philadelphia. Presented with the compliments of the Engineers' Club of Philadelphia.

World's Columbian Exposition at Chicago. The United States of Venezuela in 1893. Published by order of the Government of Venezuela. New York.

Tables for the Computation of Railway and Other Earthwork. Computed by C. L. Crandall, C E. Second Edition. New York: John Wiley & Sons.

Transactions of the Liverpool Engineering Society. Vol. XIV. Edited by R. C. F. Annett, Honorary Secretary. Liverpool: Published by the Society.

British Railways: Their Passenger Services, Rolling Stock, Locomotives, Gradients and Express Speeds. B. J. Pearson Pattison. London: Cassell & Co., Limited.

Proceedings of a National Convention of Railroad Commissioners, held at the office of the Interstate Commerce Commission, Washington, D. C., April 19, 20, 1893.

Addresses Delivered before the World's Railway Commerce Congress. Held in Chicago, Ill., June 19–23, 1893. Chicago: *The Railway Age and Northwestern Railroader*.

Compound Locomotives. By Arthur Tannatt Woods. Second Edition, Revised and Enlarged by David Leonard Barnes. Chicago: *The Railway Age and Northwestern Railroader*.

Interstate Commerce Commission's Fourth Annual Report of the Statistics of Railways of the United States. Washington: Government Printing Office. (655 pp., 5¼ in. × 9 in.)

Continuous-Current Dynamos and Motors, their Theory, Design and Testing. An Elementary Treatise for Students. By Frank P. Cox. New York: The W. P. Johnston Co., Limited.

The Science of Mechanics. A Critical and Historical Exposition of its Principles. By Dr. Ernst Mack. Translated by Thomas J. McCormack. Chicago: The Open Court Publishing Company.

Fifth Special Report of the Commissioner of Labor. The Gothenburg System of Liquor Traffic. Prepared under the direction of Carroll D. Wright, Commissioner of Labor. By E. R. L. Gould. Washington: Government Printing Office.

TRADE CATALOGUES.

How to Select Drawing Instruments, Keuffel & Esser Company, 127 Fulton Street, New York. This is a small pamphlet of 12 pages (5¼ × 8¼ in.), whose purpose is indicated by its title. It is illustrated by engravings of various kinds of instruments sold by this Company, and contains many hints to draftsmen about the choice of instruments.

Messrs. A. Whitney & Sons, of Philadelphia, manufacturers of car wheels, have republished the circular of inquiry of the Committee on Cast Iron Wheels appointed by the Master Car-Builders' Association, with their own reply to the inquiries and the report of the Committee. The significance of the publication is the bearing it has on the advantages of a contracting chill in making cast-iron wheels.

The Siemens & Halske Electric Company of America, whose headquarters are in Chicago, have issued a pamphlet describing different applications of electric motors to the operation of machinery under the patent granted to Carl Hofman and Ernest Richter, of which the above Company are the assignees. The pamphlet is intended to explain the application of the inventions covered by this patent, and the Company announce that they will issue licenses to use the invention for a nominal consideration.

The Berlin Bridge Company have issued a very neat little "folder" announcing that their new catalogue of over 300 pages, illustrating and describing iron buildings for machine shops, foundries, rolling mills, casting shops, electric light and power plants, is now ready for distribution. The expense of this catalogue is so great, they say, that they cannot afford to send it broadcast, but to persons who are interested in this class of work they will take pleasure in mailing a copy if they so desire.

The Bennett Manufacturing Company, 1510 Chestnut Street, Philadelphia. This Company, which is engaged in the manufacture of Engineers', Draftsmen's, and Architects' Instruments and Supplies, in the preface to the volume before us speak of it as their "introductory catalogue." It contains 24 pages (5¼ × 8¼ in.) which contain some very excellent engravings of the instruments made by them. In the preface they say:

"The adaptation of aluminum in the manufacture of scientific instruments is original with us, and we are at present the sole producers of such goods, having exclusive advantages in regard to the treatment and use of this comparatively new and wonderful metal which other houses have not been able to attain. Instruments made of aluminum are cleaner and lighter and quite as substantial as German silver, besides possessing the added advantage of being non-corrosive."

We have had the privilege of handling some of these instruments, and they certainly have the merit of being much lighter than those made of German silver. Some novelties are illustrated in the catalogue, among them what is called a duplex pen for drawing heavy and light lines at will, which commends itself at sight to an experienced draftsman.

Cranes and Special Railway Appliances, as Designed and Built by the Industrial Works, Bay City, Mich., 107 pp., 6¼ × 10¼ in. This book is another excellent example of the kind of literature of which our manufacturers are now so prolific. It is illustrated with the usual half-tone prints, the first two being interior views of their works. These are followed by illustrations and descriptions of a traveling crane in the Chicago, Milwaukee & St. Paul Railway shops, a walking jib crane, a pillar crane for yard work, a transfer crane for freight yards or stations, a 35-ton steam-wrecking crane mounted on a car, double wrecking cranes mounted on a long car, a 20 ton construction and yard crane, a locomotive crane, a steam railway crane, a double hand-wrecking crane mounted on a car.

In the second division of the book various hints of excavation pile drivers, transfer tables, portable steel rail saws are described. The book is an indication of the extent to which cranes are being employed in this country. Their manufacture is a comparatively new industry, which is or was growing very rapidly. If this company could only equip the Senate chamber in Washington with an overhead crane with sufficient capacity to lift the members out of the slough into which they have fallen, the business of crane making would probably improve.

Gould Coupler Company. Malleable Iron Works, Depew, N. Y., Steam Forge, Buffalo, N. Y. The catalogue of this Company is a volume of 47 pages, 9 × 12 in. It is elaborately illustrated with "half-tone" and "wax-process" engravings, and is printed on heavy coated paper, in large type, with wide margins. The frontispiece is a bird's-eye view of the new Malleable Iron Works at Depew, which is apparently made from a very good wash drawing. This is followed by views of the Steam Forge of the Company, made from photographs. A brief description of these two establishments follows, giving their location, size, etc. The next engraving is an end view of a freight car equipped with the coupler which this company manufactures. Four full-page engravings show the detached details which are all numbered and their names given in a printed list opposite. On one page the parts are shown in outline, and their dimensions are given. A full-page perspective view and outline drawings of the details of a tender coupler are shown.

Similar views and descriptions are also given of the Gould Pendulum Vestibule and the company's Buffer and Continuous Platform.

The latter part of the book contains interior views of the Forge, showing a steam and trip hammer and their products, consisting of axles, links and pins, etc.

Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis. Catalogue Part I, Steam Shovels; Parts II and III, Dredging and Excavating Machinery.

These books are also 9 × 12 in., the first having 43 and the latter about twice that number of pages, which are not numbered. In the first the works and their location are described. Seven different forms and sizes of steam shovels mounted on railroad cars are illustrated by perspective views made from photographs, and by outline engravings made from drawings. The construction of these is described in the preliminary pages. There is then a very good view of a Fox pressed steel truck, and outline engravings of what is called a "land dredge" mounted on wheels suited to run on a temporary track. Accounts of the capacity, range of work, and material in which it can be advantageously used completes the volume.

The II and III parts of this Company's catalogue are illustrated by similar illustrations to those which have been described. There are eight full-page views of different kinds of dipper dredges—that is, dredges which consist of a dipper or bucket operated from the end of a boom. Four views of hoisting engines are shown, one of a steam cylinder for operating hoisting frictions of dipper dredge, and another interior view of a dredge showing the boiler engines and hoisting machinery. The succeeding part of the book contains 10 very interesting views made from photographs of dredges which have a series of buckets operated by an endless belt or chain. Several pages of details of these machines complete the volume.

The criticism which we feel inclined to make of these publications is that they do not contain enough descriptive matter. A novice naturally looks to a book of this kind for information on the subject to which it relates. It seems as though such a book ought to contain an elementary treatise on dredging, showing and explaining what kind and quantity of work can and cannot be done by such machines, where and how they can be used to advantage, the principles of their construction, their weak and strong points, what those using such machines should do and what they should avoid, and although this need hardly be pointed out, the peculiar points of excellence of the machines illustrated. Such a treatise would be of permanent

value to those interested in them, and probably no one is more competent to give such information than the makers of these machines.

The same Company also send a smaller pamphlet, which describes the machinery they make for placer mining, which is somewhat out of our line. The books are all well illustrated, well printed on good paper, and give an excellent idea of the general character of the appliances manufactured by this Company.

THE DODGE MANUFACTURING COMPANY, of Mishawaka, Ind., have published what they call a Souvenir Pamphlet of the World's Columbian Exposition. The striking feature at the first glance is the beautiful color, texture, and typography of the cover. The paper has a rough surface, the title being printed in fancy type in dark green ink of some kind which has a glossy surface.

The pamphlet gives a history of this establishment, which was started in 1878 for the manufacture of "wood hardware." In 1881 the works were destroyed by fire, and as stated, "certain pulleys were constructed of wood and with the bushing system, which proved so satisfactory that it was decided to make wood pulleys the main feature of manufacture. The difficulties in the production of wooden pulleys capable of competing with iron pulleys in other respects were not overcome until the ingenuity and skill in this Company produced the Independence Patent Pulley. One of its principal features is the system of interchangeable bushings, whereby any pulley may be fitted to a shaft of any diameter."

At present this Company do an immense business, and have over 600,000 of them in use. The business has developed to a tremendous proportion, and is now a distinct branch of American mechanical engineering.

Besides wooden pulleys this Company also manufacture a patent system of power transmission by manilla rope, a full line of mill and factory furnishings, such as drop hangers, post hangers, pillow blocks, floor stands, friction clutches, etc., all from new designs and patterns.

Among the illustrations in the book is a view of the interior of the engine-room of the works, which is said to be "one of the finest engine-rooms in the United States, if not in the world," and the statement is entirely credible. The walls, ceiling, and floor are elaborately decorated, a highly ornamental fireplace and a desk give an air of comfort and convenience which would not be expected in such a place. An American eagle surmounts the mantel and inspires patriotic feelings.

The description of this establishment shows us another instance of how "tall oaks from little acorns grow" in this country.

THE EVOLUTION OF ARTIFICIAL LIGHT. From a Pine Knot to the Pintsch Light. Compliments of the Passenger Department Union Pacific System, Omaha, Neb., 109 pp., 5 × 7¼ in. At first sight the purpose of this luxuriously printed book is not apparent. It is bound on the short side, and is thus what may be called a dwarf volume. The cover is rough white paper, with the title printed in colors and gold, and altogether is very attractive. The titles are respectively, Light of Other Days; House Light; Torches and Lamps; Candles, Lanterns and Links; Oil Light; Gas Light; Street Lights; Beacon Lights; The Electric Light; The Pintsch Light; Railway Car Lighting. In these the history of the various kinds of lighting is given in considerable detail, and many interesting facts are related. The purpose of the book is skillfully interwoven into the last chapter, in which the method of lighting the Union Pacific cars with the Pintsch light is described, which description is succeeded by the statement that "this great national highway is so well known," etc. Then follows a description of the line, its attractions, advantages, etc. There is a map of the line, a view of the mammoth natural gas well near Salt Lake City, another of a young lady "on the beach at Garfield," who is displaying her nether limbs rather promiscuously; a scene near Leadville, Col.; another of the loops above Georgetown; one of Platte Cañon; the Ames monument at Sherman, Wyo.; the great Shoshone Falls, Ida.; Cloud Cap Inn, on summit of Mt. Hood; Mt. Hood itself; Echo Canon, Utah; Witch Rocks, Echo Canon, Utah; Pulpit Terraces, in the Yellowstone National Park, which completes the illustrations.

The book is a probable forerunner of a kind of composite literature in which advertisements of our leading lines of railroad will be interwoven with all kinds of interesting reading matter. We may have a railroad novel in which the characters will be skillfully made to speak words of commendation for the great Cross Cut line. We may have poetry whose meter will accord with the rattle of rail joints and resound with praise of the latitudinal road, or a tragedy which may culminate in a railroad accident on the competing line, with the principal characters appearing in the last act in various conditions of dismemberment, and expressing remorse that they did not take the Interpolar route, and wildly imploring every one else to do the same thing. There is no telling what the authors of this kind of literature may have in store for us.

SANDY SKIRLED AWA' AND DROWNED THE ELECTRICAL PIANO.

THE Chicago *Herald* of some weeks ago contained an account of an interesting episode which gave variety to the monotony from which the exhibitors suffered at times in the Transportation Building of the great show in Chicago. Back of the model of the village of Pullman, in this building, were the exhibits of three manufacturers of car seats. One was a Philadelphia establishment, the next came from St. Louis, and the third was from a Chicago house, which was presided over by a gentleman with a military title and character, and "whose sunny disposition," the *Herald* says, "is announced in a smiling face and a full waistcoat." The Philadelphia exhibit was presided over by an enterprising young gentleman who is very zealous in the interest of his employers. As we cannot hope to emulate the graphic style of the *Herald's* reporter, in describing the episode referred to, we quote from him, with some omissions of names, etc.

The *Herald* says things were getting dull in Transportation Building when the young gentleman in charge of the Philadelphia seats conceived the brilliant idea of attracting attention to his exhibit by providing music in his booth. The music had to be cheap, noisy, and continuous to suit his idea, and he considered that he had struck the very thing when he leased a piano that is run by electricity. So it came about that one morning last week the ears of all the exhibitors within hailing distance of the booth in charge of the enterprising young gentleman were assailed by the strident notes of "Maggy Murphy's Home," followed by "Down Went McGinty," and similar choice selections.

A troubled look came over the genial countenance of our martial friend when the electrical nuisance broke forth in melody. The rotund representative of the Chicago patent reversible chair-car seat leaned back in one of them, thrust his fingers into his ears and puckered his brows in thought. Suddenly his expression changed; he sprang to his feet, slapped his leg, and said to himself, "I'll do it."

In a trice he was hurrying to the terminal station, and the first north-bound Illinois Central express train carried him to the city, leaving the young Philadelphian and his piano surrounded by an admiring crowd, in undisputed possession of the field. The man of war presently reappeared in the Transportation Building. By his side strode a big, raw-boned Scotchman. The man from the land of Bobby Burns was clad in a kilt and wore a Tam o' Shanter, a big green plaid tartan, and over his shoulder he carried a set of Scottish bagpipes.

Our friend from the Quaker City was at lunch when the Scotchman appeared on the scene, and the electrical piano was silent. The Commander-in-Chief of the Chicago exhibit in the mean while deployed the man with the bare legs and the bagpipes up in the end of his booth near his rival's exhibit, and after some whispered instructions retreated to his desk, chuckling to himself meanwhile.

Soon after 1 o'clock the Philadelphian hurried into his booth, grinned at his friend across the way, and turned loose the piano. The General sprang to his feet, as the first offensive notes floated out on the hot afternoon air, and shouted, "Skirl awa', Sandy."

The big piper started "The Campbells are Coming." High above the brassy rattle of the piano sounded the wailing notes of the bagpipes. The Quaker music was completely drowned out. The crowd that had been pressing about the Philadelphia booth turned to the new attraction and forgot the old. Back in the corner our military friend laughed so immoderately that his face was the color of the crimson plush seat on which he sat. All the afternoon the fun was kept up. Whenever the piano began to tinkle the piper began to blow. The following morning "Sandy" was reinforced by one of his countrymen, and all day long the man of war and the Scotchman had fun with their friend and his automatic music box.

The space about the Chicago exhibit was packed with people, but it would be difficult to say whether they were most amused at the pipers or the little fat man who held his sides and

laughed till the tears ran down his face every time a new tune was struck up.

While all this was going on the philosopher from the banks of the Mississippi, in charge of the St. Louis exhibit, was engaged in sage elucidation of the superiority of the Scarritt seats to admiring crowds, and showed conclusively that the chariot which carried Elijah up into heaven by a whirlwind was provided with one of them, with a flexible back and adjustable foot-rests; and when the Philadelphian heard of it, it is said that "he took hold of his own clothes and rent them in two pieces."

NOTES AND NEWS.

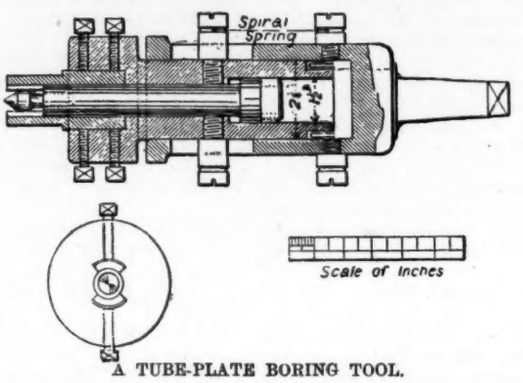
A New Explosive.—A commission of German artillery experts have been testing a new explosive with which it is proposed to replace gunpowder in the German army. The explosive is a brown fatty substance of the consistency of frozen oil when exposed in ordinary temperatures. It retains this consistency up to 112° F. A shock or a spark does not set it off. When used in guns, the explosion is obtained through contact with another chemical compound. The explosion is almost unaccompanied by smoke, and the detonation is inconsiderable. The recoil is very slight, even when the heaviest charge has been used. The explosive does not heat the weapon sufficiently to cause difficulties in the way of rapid firing, and cartridges once used are easily refilled.

For the present rifle the new compound is not available, but if future tests be as satisfactory as the recent ones, it will be introduced generally in the artillery branch of the service.

Railroads in Newfoundland.—At present there is a railway, 84 miles long, from St. John's to Harbor Grace, with a branch line of 25 miles connecting with Placentia. Another railway has been in the course of construction for over two years toward the Exploits River and on to Hall's Bay, thus going northward through the center of the island. About 140 miles of the railway are said to be completed, and the whole is expected to be laid down by the end of 1894. The new contract is for a railway of 250 miles to connect these railways with the west coast by way of the Bay of Islands, St. George's Bay, and Port Basque Bay, in the southwest corner. Thus the main part of the island, leaving out the long northern peninsula, will within a very few years be covered with a net work of railways, which will leave no excuse for the non-development of the resources of the interior. That interior is in many parts almost unexplored, though it is believed to contain mineral and timber resources of which much could be made. What are the agricultural capabilities of the interior remain to be seen. Over the internal resources of the colony no foreign nation has any lien; and the unrestricted development of these cannot but place Newfoundland in a condition of prosperity, which she has never yet attained. The contractors for the new line, who are also to work for 10 years the Hall's Bay and Placentia Line, seem to have made a very good bargain for themselves. In addition to the cost of construction, they are to receive two and one-half million acres of land, with the mineral and timber rights upon it, along the new line, and a subsidy of $36,000 per annum for the carriage of the mails. If they set to work in earnest in the development of their extensive property the result cannot but be for the benefit of the colony at large.—*The London Times.*

A Steam Artillery Wagon.—M. Serpollet, who in 1888 brought out his instantaneous steam boiler, has since then adapted it to a variety of vehicles, including the cycle, phaeton, omnibus, and now, at length, the artillery wagon. The French artillery wagon is very large, and contains a load of 1,500 kilogrammes. Moreover, it should attain a speed of eight kilometers an hour, and be able to run for 40 kilometers without a halt A second wagon is sometimes taken in tow with a load of 3,000 kilogrammes, and in this case the speed ought to be about four kilometers an hour on the average. M. Serpollet had also to fit the new motive power to the existing wagons. His motor is capable of supplying 40 H.P., and the boiler can support a pressure of 25 atmospheres. The power applied to the wagon can be quickly increased to meet obstructions and other difficulties of the road, thus imitating the action of horses. The motor is fixed under the rear of the wagon, and actuates the hind wheels by means of chains. The weight is balanced by the generator, which is placed in the front of the wagon, where the proper controlling apparatus is also situated under the hands of the driver. Inclines of 18 in 100 have been successfully surmounted by the wagon in several trial runs of 40 kilometers, and the expenditure of coal at a speed of 14 kilometers an hour was 2.5 kilogrammes per kilometer, while the consumption of water was 13 kilogrammes for the whole run. The weight of the vehicle and its load was 4,300 kilogrammes. The cost is therefore estimated at one-third of the expense of horse traction, and the steam wagon has this advantage, that it requires no rest, provided the supply of fuel and water is kept up. It is probable that many omnibuses and other heavy vehicles in France will now be propelled on the Serpollet system.

Tube-plate Boring-tool.—The accompanying illustration represents a tool which was patented several years ago. We have seen it in operation on the continent, and can answer for the excellence of the work done by it. The construction will be clearly understood from the cut. In an outer casing, provided at the top with a shank for insertion in an ordinary drill chuck, is a circular annular piston, having at its lower end the tool holder. In this annular piston works a second small piston with a stout piston-rod terminating in a hard steel center. The space above the two pistons is filled with thick oil. The area of the annular piston is 2.2 sq. in., that of the smaller piston 1.8 sq. in.



A TUBE-PLATE BORING TOOL.

The tool is mounted as a drill in any suitable drilling machine. The centers of the holes to be bored are marked deeply with a center punch. The tool is lowered in the ordinary way by the mechanism of the machine till the center presses firmly into one of the punch marks. As the pressure is increased it is evident that the external annular piston descends, forcing the tool against the plate. The tool revolves and the hole is cut, and as the center is always firmly pressed against the plate, the tool turns without any "wobble" or "dither," and the hole is cut perfectly true. On releasing the pressure the spiral springs at the sides draw the tool back to its normal position. The two lower studs to which the springs are attached pass through slots in the outer casing, and the end of one of them projects into a keyway cut in the piston-rod, so that all three parts rotate together. The tool and tool-holder are of very simple construction, and will be readily understood from the cut.

The Rifle Trenching-tool.—A correspondent of the London *Times* writes to that paper: "Attempts have often been made to supersede the independent trenching-tool at present in use in the army by one in which the soldier's rifle should be employed as the stock or handle. In these attempts the spade portion has generally been connected up with the barrel of the rifle, which method is open to objection. A new system, in which the trenching-tool is connected to the butt-end of the rifle, has been invented by Captain Léon de Layen, a French military officer who has seen some service, and was recently tried on the parade-ground of the Honorable Artillery Company at Finsbury. The tool consists of a steel spade having a short square shaft or handle formed upon it, the tool being carried in a leather case on the soldier's breast. To the stock of the rifle is attached a steel socket in which the tool is fixed when wanted for use, being firmly held by a spring catch and released by the pressure of the thumb. Equipped with this tool Captain de Layen went through trenching and various other drills, and demonstrated that the tool in no way interfered with the drills, subject to one or two slight alterations in them. It was shown that bayonet drill and firing were also easily performed, while, if the men were surprised at close quarters during trenching work, the spade attached to the butt of the rifle made a ready weapon in place of the bayonet. The equipment and rifle were then transferred to an assistant, who was given 10 minutes to intrench himself. In five minutes, in the opinion of some military officers present who had

seen service, he had thrown up a good shelter, and by the end of the 10 minutes had well intrenched himself. A squad then opened fire upon him, and he replied with the trenching-tool still fixed. The firing party then advanced and he retired a given distance, firing on the way, and when the marked point was reached he commenced to throw up another shelter, which he sufficiently completed in two minutes, and he then recommenced firing on the enemy. The opinion of the officers present was that it was an efficient tool, and that in use it was not in any way calculated to injure the rifle, which, in working, is gripped by the breech-end of the barrel and the throat of the stock. The leading idea is that every infantry soldier should become a sapper and miner or an engineer."

On the Life of Iron Bridges.—The following letter has lately been addressed to a member of the Glasgow Town Council by Sir William Arrol: "I am in receipt of yours of the 4th inst., and in reply have to say that if the convener is under the impression that the life of an iron bridge is only 40 years, he is under a mistake, as the life of an iron bridge depends entirely on how it is kept and the material with which it is painted for its preservation. I may say that in my experience I have examined a considerable number of iron bridges, and one I examined was up for 50 years, and the parts of it which were properly looked after were practically as good as on the day they left the works. Some three months ago I examined another brid e over a river; it had been up 30 years, and had not been painted for 15 years, but there was very little corrosion, the parts that were rusted were parts where drips of water had fallen and had not been properly attended to. Then, again, I examined another a few weeks ago which has been up 38 years, and every part of that bridge is practically as good as on the day it was put up. A few years ago I bought the material of the old Hammersmith Bridge, London, for the purpose of using it as a temporary plant in the erection of the Forth Bridge. It had been up for 62 years, and a great many of the parts had not been painted since its erection, as it was impossible to get at them; yet these parts were in a good state of preservation—in fact, quite as good as when they left the works. I took some of the material with which it had been painted to ascertain the reason for the good state of preservation it was in, and the result of the analysis was that the material with which it had been painted was genuine white lead. You can see from these samples that an iron bridge, properly taken care of by those responsible for it, will last practically for any length of time. The Bonar Bridge, which we have just replaced, was carried away by the strong floods; it had been up for 80 years. The iron part of the bridge, which was 150 ft. span, was perfectly good, but the masonry piers got scoured out and washed away, therefore the iron work fell into the bed of the river and was destroyed."

SPEAKING at the Engineering Congress at the World's Fair, Sir Benjamin Baker stated that in examining old wrought-iron bridges he had found that the bridges had suffered most at the joints, and not at places where the strain sheets would show the greatest fatigue. In the case of bridges having trough floors, for example, he had found that the failures were serious where the flooring was connected to the webs of the main girders. He had seen the web-plates nearly cut through with the wriggling of the connections, and considered it to be better practice to put the troughs directly on top of the angle plates. In other riveted parts he had found the greatest wear from the loosening of the rivets.

The Phonograph as a Cure for Deafness.—Dr. George A. Leech recently delivered a lecture at the Leech Institute, 39 West Twenty-seventh Street, New York, on a new method of curing deafness by means of the Edison-Leech phonograph. Illustrations were given of his method of treating deaf patients by introducing into the ear a vibratory piece of an intensity sufficient to cause even deaf-mutes to hear. The New York *Times* gives the following report of this lecture:

"I regard the Edison phonograph as the most wonderful invention of an age remarkable for its great discoveries. It is the human voice and the human ear rolled into one.

"But it was not designed as an instrument for the cure of deafness until I invented and applied to it certain apparatus which makes it complete for that purpose. In order to hear, it is absolutely necessary that three little bones called the hammer, anvil, and stirrup, situated in a little cavity known as the drum or middle ear, should be made to vibrate at a certain rate of speed."

After explaining how these bones were connected, and the manner in which sound was conveyed to the auditory nerve and brain, he said: "The speed with which these bones move varies from 16 to 30,000 times in a second. Vibrations slower than 16 times a second are not fast enough to be recognized as sound by the human ear, while those exceeding 30,000 vibrations are so rapid as to be beyond its capacity for hearing.

"A person is deaf when the joints of these bones become stiff and do not respond properly to the vibrations of sound, and the degree of deafness is measured by the amount of stiffness in these joints.

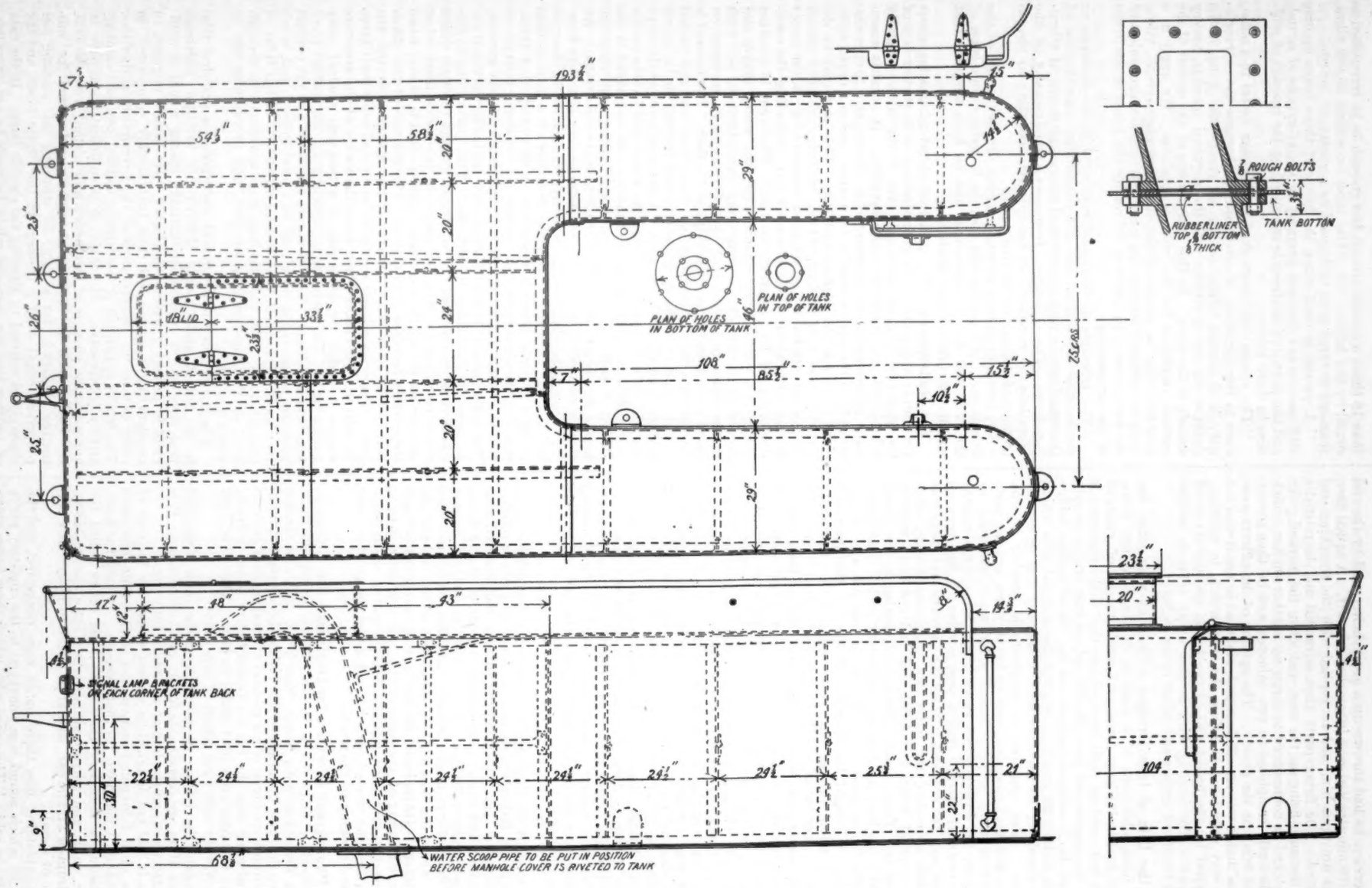
"The reason why most deaf people hear better in a noise, such as the rumbling of street cars, is because the extraordinary loud sounds falling on the ear compel the bones in the drum of the ear to vibrate with the required speed to convey sounds to the brain. In this fact lies one of the secrets of the method employed for the cure of deafness. We apply in a scientific way, by means of the improved phonograph, vibrations of sufficient intensity to move the delicate mechanism of the human ear. In this way we render the joints in the drum of the ear movable.

"The principle of treatment employed is the massage, or mechanical stimulation, and the consequent reawakening of the sound-conducting apparatus of the ear, by means of vibrating force. The character, frequency, and intensity of the vibrations are regulated by the surgeon, according to the exigencies of the case under treatment."

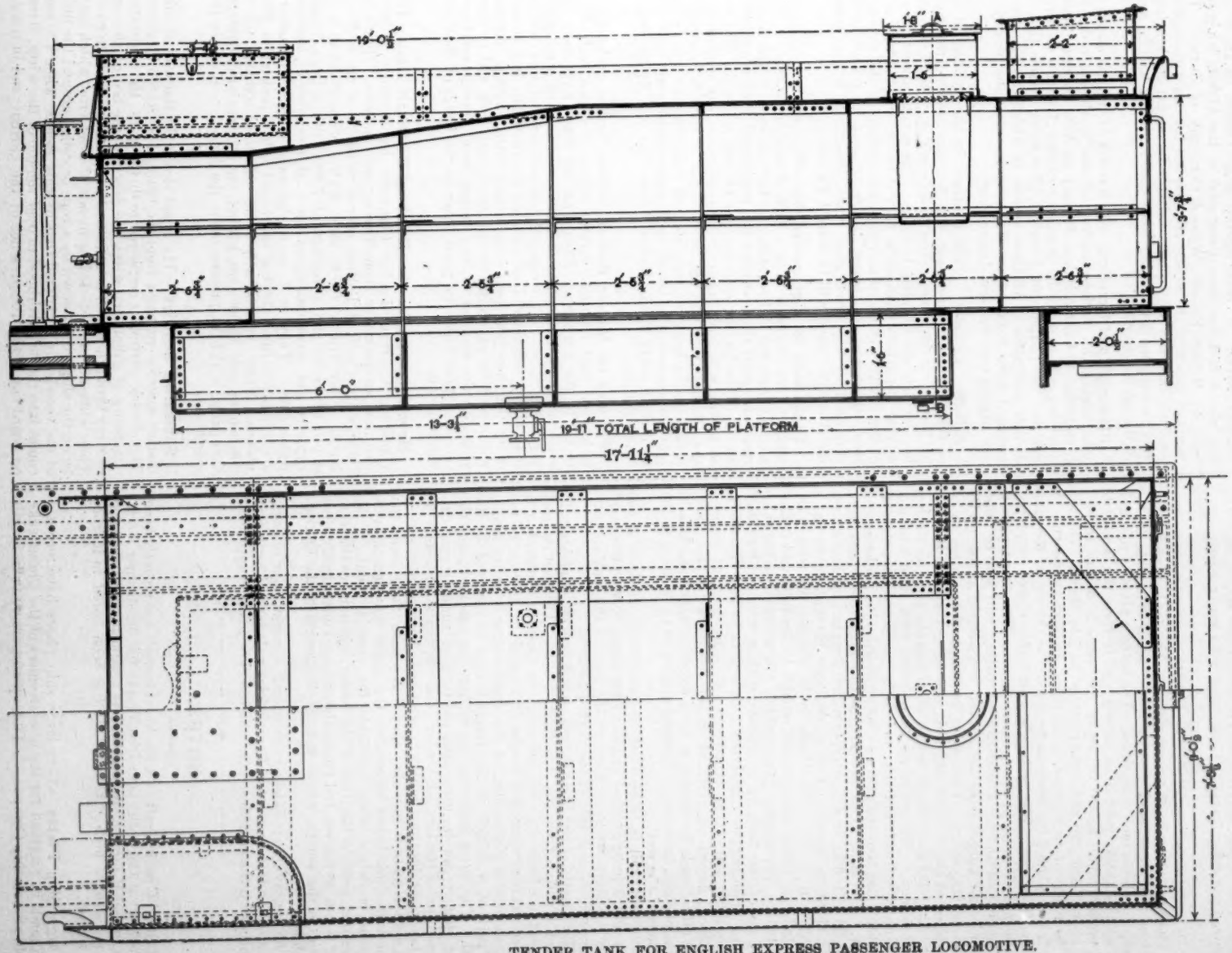
Dr. Leech explained at much length the mechanism of the human ear. His system will soon be introduced into some of the deaf and dumb institutions, and he feels sanguine that wonderful cures will be effected.

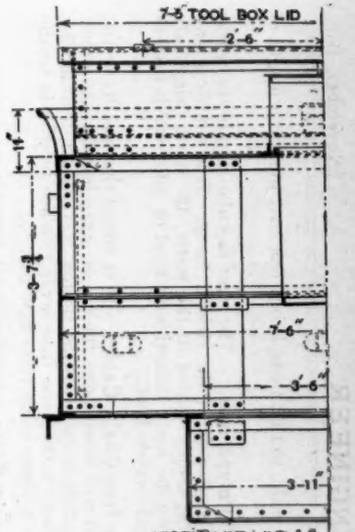
The Hydrophone.—The principal object of this ingenious yet simple apparatus is to give warning to a port or fleet of the approach of a torpedo-boat, even if the latter is totally submerged and therefore quite invisible. It consists essentially of two parts, one submerged in the sea at a proper distance from the port or fleet to be warned, and at a depth sufficient to escape the surface agitation. This part may be described as an iron bell-jar, which, on being plunged mouth downward into the water, retains a volume of air in the upper portion or bottom, where a copper box, protecting the sensitive organ of the apparatus, is fixed. The organ in question is merely a very delicate vibratory contact, which makes and breaks an electric circuit connecting the submerged bell with the indicator or second part of the hydrophone, situated on shore or on board one of the ships of the fleet. The contact is formed by a flat horizontal spring fixed at one end and loaded at the other by a heavy piece of brass, having on its upper surface a small platinum stud. A fine platinum needle kept upright by a vertical guide rests its lower end loosely on the platinum stud. The needle and the stud are connected in the electric circuit through the guide and spring, and when the needle dances on the stud the circuit is made and broken. An electric current from the ship or shore battery is always flowing through the circuit—that is to say, between the submerged bell and the indicator. Now the propeller of a torpedo-boat or of a torpedo sets up vibrations in the water, and these, reaching the submerged bell, agitate the trembling contact, so that the needle dances on the stud and interrupts the current. The consequence is that the indicator begins to work and announces the submarine disturbance. This part of the hydrophone consists essentially of an electro-magnet through which the current passes, with an armature free to oscillate when the current is rapidly made and broken—that is to say, when the current becomes intermittent. The motions of this armature can be seen by an observer if he chooses to watch, but actual observation is not required, for the indicator itself gives the alarm. This takes place when the swing of the armature carries it within the attraction of a magnetic contact piece fixed near it. The armature is then drawn to the contact piece and held fast there. The swinging armature and the contact piece are connected in the circuit of a local battery, and, when they meet, the current flows to ring an electric bell or light an electric lamp. The torpedo-boat thus announces its own arrival on the scene in spite of itself, and precautions can be taken against it.

The hydrophone is at present undergoing a practical trial in the Solent, and Captain M'Evoy, the inventor, estimates that three of the instruments suitably placed would be sufficient to protect Portsmouth Harbor. He is now engaged in constructing a larger bell than that already submerged, in order to meet the requirements of the government authorities. The whole apparatus is beautifully worked out, and comparatively inexpensive. Moreover, it is sufficiently sensitive to announce the passage of steamers a mile distant from the bell. Obviously such an instrument might also be used for submarine signaling, for a ship, by stopping and starting her propeller, could send a message in the Morse Code, and the shore could respond by flashing the electric lamp. In the case of another ship the response might be made by her propeller. —*The London Times.*

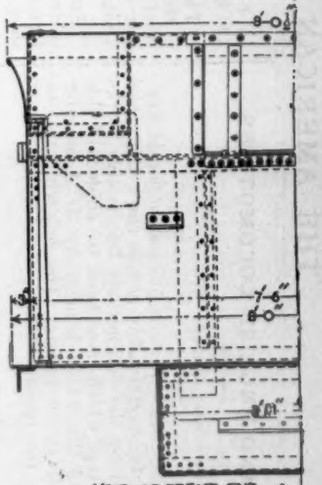


TENDER TANK FOR AMERICAN EXPRESS PASSENGER LOCOMOTIVE.





SECTION ON LINE A.B.



VIEW OF FRONT END

TENDER TANK FOR ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

AMERICAN AND ENGLISH LOCOMOTIVES.

(*Continued from page 469.*)

OUR engravings illustrating features of construction of English and American locomotives this month show the tanks which are furnished by the Schenectady Locomotive Works for engines of the type which have been the subject of this series of articles, and that which is made by Mr. Adams for the London & Southwestern engine. The following are the specifications for the two tanks:

AMERICAN TANK.

To be of 3,500 galls. capacity, strongly put together with angle-iron corners, and thoroughly braced and stayed, and well secured to tender frame. Tank fitted with water scoop.

ENGLISH TANK.

The tank to be of the form shown. The tank plates to be of the Best Best Staffordshire iron. Each side plate of the tank is to be in one, ¼ in. thick. The bottom plate of the tank to be ⅜ in. thick, jointed as shown, and to form the foot plate of tender. The height of top of foot plate from rail to be 4 ft. 1½ in. The end and front plates to be ¼ in. thick. The top to be made of two plates $\frac{5}{16}$ in. thick, jointed as shown. A stiffening plate ⅜ in. thick to be riveted to the top of the tank at the front end. The tank to be thoroughly stayed by plates, angle and T-irons in the manner shown. The front plate is to be cut out to form a doorway by coaling, and is to be fitted with a door hinged from the bottom and secured at the top by suitable fastenings. Two wrought-iron tool-boxes are to be provided at the front of the tank, one on each side of the tender. Another tool-box is to be fixed across the tank on the top of the back. All tool-boxes to be fitted with false bottoms, perforated with small holes, and to be perfectly watertight at the top; the tool-boxes are to be provided with padlocks and keys. The tank to be provided with a manhole or tank filler and lid 1 ft. 6 in. in diameter, to which is to be attached a suitable sieve, as shown. The angle irons throughout to be 2½ in. × 2½ in. × ⅜ in. The tank to be riveted up with ½-in. rivets 1⅝ in. pitch, countersunk outside in the sides and end of the tank. The coping plates which are attached to the sides and end of the tank to be finished with a wrought-iron half round moulding piece, as shown. A well to be provided 13 ft. 3¼ in. long, 3 ft. 11 in. broad and 1 ft. 6 in. deep, of plates ¼ in. thick, stayed and riveted in the same way as the tank. One filling cock for bucket is to be fixed on right-hand side in front of tank, as shown. A washout plug is to be fitted to the bottom of the well.

One hand rail is to be fixed on each side of the back of the tank and is to be finished bright; four lamp irons to this company's pattern are to be fixed on the back of the tank and one lamp iron on each side of the tank, as shown.

The "well" of the English tank, it will be seen, is a feature in which it differs from the American design. This can be used when the wheels are arranged as in the English tender, but is impracticable when the tender is carried on trucks, as the frames, center plates, etc., of the trucks must be in the space, or part of it, which in the English tank is occupied by the well. The latter increases the capacity of the tank, and the fact that it can be used with the form of running gear employed under the English tender is an additional advantage in its favor besides those which have already been pointed out.

Another feature in which they differ is in their form, the American tank being bifurcated, the space between the two legs or branches being available for carrying coal. This, therefore, rests on the floor of the tender, where it would seem that it can be broken and manipulated more conveniently than on top of the tender, where it must be carried in the English vehicle.

The engravings published this month complete our illustrations of the two engines. The articles will be finished next month with the specifications, which will be given complete.

NOTES.

A Steel Crank-shaft.—A steel crank-shaft has recently been turned out at the Bethlehem Iron Works for the steamer *Paris*. It is intended for a spare shaft. The tensile strength is 90,000 lbs. per square inch. A 5-in. hole has been bored in it from end to end.

Large Ship Plates.—Very large ship plates have recently been made in England for the new steamers of the Chesapeake & Ohio Steamship Company. These plates are 60 ft. in length by 4 ft. wide, so that there is but one butt joint in a length of 120 ft.

The "Polyphemus."—The most singular ship in the world is the *Polyphemus*, of the British Navy. It is simply a long steel tube, deeply buried in the water, the deck rising only 4 ft. above the sea. It carries no mast or sails, and is used as a ram and torpedo boat.

Scrap Iron Chain Cables.—It is stated that the Navy Department will discontinue the use of scrap iron for the manufacture of chain cables at the Boston Navy Yard, tests having shown that chains made from scrap iron are inferior in tensile strength to those made from new bar.

Aluminum Boats.—London *Truth*, recently referring to this subject, says: "It may interest some readers to know that the launch that has been dispatched to the African lakes was built by Messrs. Escher, Wyss & Company, of Zurich. The boats of this firm are mostly constructed for use with naphtha engines, but they are equally suitable for steam or electricity, and we suppose that rowing boats could equally well be made of the same material."

Blowing Up of Derelicts.—As a result of the recent discussion among the various nations of the world, an order has been issued to Rear-Admiral Belknap at New London, Conn., directing him to send the dynamite cruiser *Vesuvius* on a voyage for the purpose of blowing 13 derelict vessels that endanger navigation. All these vessels to which the *Vesuvius* is assigned were wrecked on the Atlantic coast, and nearly all are adjacent to the New Jersey shore.

A New "Victoria."—The contract for the building of one of the new British ironclads will be placed with Armstrong, of Newcastle-on-Tyne. The new vessel will be 4,000 tons heavier than the ill-fated *Victoria*. The specifications contain several important changes in regard to the surplus buoyancy of the vessel. In speed and power of armament the new warship, which will cost about £1,000,000, will, it is said, be unsurpassed by any armor-clad vessel afloat. It is understood that the new vessel will be named *Victoria*.

Tank Ship for Cottonseed Oil.—The next novelty in the world of commerce is to be a bulk steamship to carry cottonseed oil from the United States to foreign lands. The American Cottonseed Oil Company has contracted with shipbuilders on the Clyde for the construction of such a vessel. The new steamship will have separate compartments for the storage of the oil, and there will not be such risk as there is in carrying petroleum in bulk. Every modern improvement will be applied to the tanker to insure both safety and speed. She will be owned solely in the United States, but will fly the flag of Great Britain.

Ferrules for Marine Boilers.—From foreign exchanges it is learned that ferrules—several forms of which were illustrated in the AMERICAN ENGINEER for May—have been officially adopted in the British Navy as a means of strengthening boiler tubes. The case of low-pressure engines will be individually considered as occasion requires, but in a general order that has just been issued ships with engines working with pressures exceeding 90 lbs. per square inch will be fitted with ferrules as soon as they return from foreign service or there is opportunity to place them in the hands of the dockyard officials.

New Steamers for the Hamburg-American Line.—The Hamburg-American Packet Company has recently ordered five new steamers for their Transatlantic service. Three of these will be built at Belfast, one at Stettin, and one at Hamburg. They will be 465 ft. long, with a beam of 52.56 ft., a depth of 35 ft., and a tonnage of 7,800, with a large freight capacity and accommodations for a large number of steerage passengers. They will have the most approved sanitary arrangements for carrying meat and other perishable provisions. These vessels will bring the total tonnage up to 206,000, or only 15,000 tons behind the Peninsular & Oriental Company, which at present owns the largest tonnage in the world.

Submarine Sentries.—The latest device in the way of submarine sentries emanates from the brain of a Scotch inventor. The electric current is employed to do the work, the apparatus consisting of submarine wires laid down in the bed of the sea or river through which intermittent currents are made to pass. These currents are detected by means of a detector, which may be on the ship, or let down by a rope or coiled around the hull of the vessel. It is claimed that by this means, when a vessel comes into the neighborhood or over the top of the wires, those on board can detect the presence of the current, and in conse-

quence can locate their position. The currents may have, if desired, different characteristics, so that the captain may distinguish in a fog whether the vessel is approaching a shoal or other submarine obstruction.

Coaling at Sea.—In connection with this subject the *United Service Gazette* (British) says: "Some interest has been aroused by experiments which were made during the manœuvres with a 'transporter,' the invention of Mr. Temperly, a shipowner. Such satisfactory results were obtained that the Admiralty have retained the appliance for further trials. It will be remembered that coaling at sea was attempted off Madeira during the manœuvres of three years ago, the discharging and receiving vessels being partially protected from one another by rope fenders of prodigious size. However, though the weather was exceptionally fine, the operation proved both difficult and dangerous, and the 'transporter' now under consideration was devised to obviate the necessity for the two vessels coming to such close quarters. It is composed of an iron girder about 30 ft. long and fitted as an overhead tramway, and it enables the two vessels to lie 25 ft. apart. It is found that with its aid coaling can go on under steam, some torpedo boats, indeed, receiving their supplies when proceeding at 10 knots an hour."

Lengthening a Steamship.—The London *Times* is authority for the following information: "The North German Lloyd mail steamer *Bayera* has just undergone an alteration of a kind that will no doubt be of interest to shipbuilders and shipowners generally. This vessel having proved herself rather too small for the Eastern traffic, her owners decided to lengthen her by 50 ft., a work requiring six months to complete, and this has been successfully accomplished at the shipbuilding yard of Messrs. Blohm & Voss, at Hamburg. Being placed in dry dock, the steamer was severed amidships forward of the engine-room, and the forepart drawn forward the required distance by hydraulic appliances. A whole compartment, 50 ft. in length, was then built on between the two portions, and the necessary strengthening effected throughout. The *Bayera* is now 450 ft. in length, and her carrying capacity for cargo has been increased by 2,400 c.m. The extra length has also added largely to the passenger accommodation. It is stated that the *Bayera* is the first large ocean steamer in which such an important and extensive addition has been made. On her recent trial trip she attained a speed of about 15 knots."

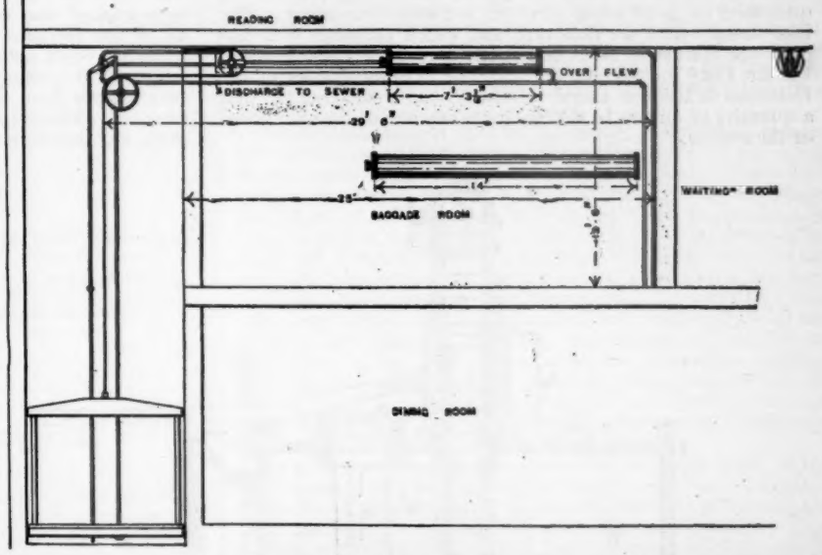
The Condition of the "Chicago."—A press dispatch says of this vessel, which is Admiral Erben's flagship, that it will probably be ordered home late in the fall, if the *New York* is ready for foreign service, to undergo extensive repairs to her boilers and machinery. Surprise was expressed when she was sent to the Mediterranean. Last December a board reported the boilers unsafe. A few hundred dollars was expended in patching them up to last through the naval review.

When orders came, after the disbanding of the fleet in New York Harbor, for her to proceed to Europe with Admiral Erben, the protestations of the engineer officers were loud against sending a ship with defective boilers to a foreign station. Her boilers will now only enable her to steam at a little better than half power, which leaves no boilers for reserve steam in case of accident. Of her six boilers, two have been useless since she left New York. The reports of the board last December stated that all of them were badly "fatigued," which means that the plates were in such condition as to render the boilers liable to explosion without further warning.

The engines were obsolete at the time the *Chicago* was constructed, and the boilers insufficient to generate steam to give her the speed the vessel should make. She has been in commission and on active service for eight years with few repairs to her machinery, and she cannot last much longer as a cruising ship unless new boilers are supplied. Plans have been prepared by the Bureau of Steam Engineering for entire new engines for the ship. With triple-expansion engines and new boilers she would be an 18-knot vessel, and one of the most useful cruisers in the service. Her best speed now is not over 11 knots. Fully $500,000 is necessary to make the *Chicago* practically a new vessel.

The Naval Armaments of Europe.—A British Parliamentary paper has been issued containing a return of seagoing warships in commission, in reserve, and building, and showing the naval expenditure, revenue, tonnage, of mercantile marine, and value of sea-borne commerce of various countries for the year 1893; also a return showing naval expenditure on seagoing force, the value of sea-borne commerce (exclusive of interchange with the United Kingdom), and the revenue of British self-governing colonies for the year 1893. It appears that Great Britain has in commission 24 battleships, four coast defense ships (armored), 63 cruisers (armored and unarmored), and 78 other ships, not torpedo boats; in reserve 10 battleships, 16 coast defense ships (armored), 49 cruisers (armored and unarmored), and 50 other ships, not torpedo boats; and building and completing for sea nine battleships, 19 cruisers (armored and unarmored), and 23 other ships not torpedo boats. France has in commission 19 battleships, five coast defense ships (armored). 23 cruisers (armored and unarmored), and 50 other ships not torpedo boats; in reserve, five battleships, three coast defense ships (armored), 20 cruisers (armored and unarmored), and 62 other ships not torpedo boats; and building and completing for sea eight battleships, two coast defense ships (armored), 19 cruisers (armored and unarmored), and five other ships not torpedo boats. Russia, in commission, five battleships, nine cruisers (armored and unarmored), 34 other ships not torpedo boats; in reserve, two battleships, nine coast defense ships, six cruisers (armored and unarmored), 37 other ships, not torpedo boats; building and completing for sea, eight battleships, four coast defense ships, two cruisers (armored and unarmored), four other ships not torpedo boats. Germany, in commission, 11 battleships, 14 cruisers (armored and unarmored), 19 other ships not torpedo boats; in reserve, three battleships, six coast defense ships (armored), 17 cruisers (armored and unarmored), five other ships not torpedo boats, building and completing for sea, seven battleships, three cruisers (armored and unarmored), one other ship not a torpedo boat. Italy, in commission, four battleships, eight cruisers (armored and unarmored), 16 other ships not torpedo boats; in reserve, nine battleships, five coast defense ships (armored), five cruisers (armored and unarmored), 26 other ships not torpedo boats; building and completing for sea, four battleships, 13 cruisers (armored and unarmored), three other ships not torpedo boats. Other countries covered by the returns are Spain, Austria, Netherlands, Portugal, United States, China, Japan, Chili, Brazil, Argentine.

BAGGAGE LIFT, PLATTSBURGH DEPOT, DELAWARE & HUDSON CANAL CO.



SPECIAL TOOLS OF THE DELAWARE & HUDSON CANAL COMPANY'S SHOPS.

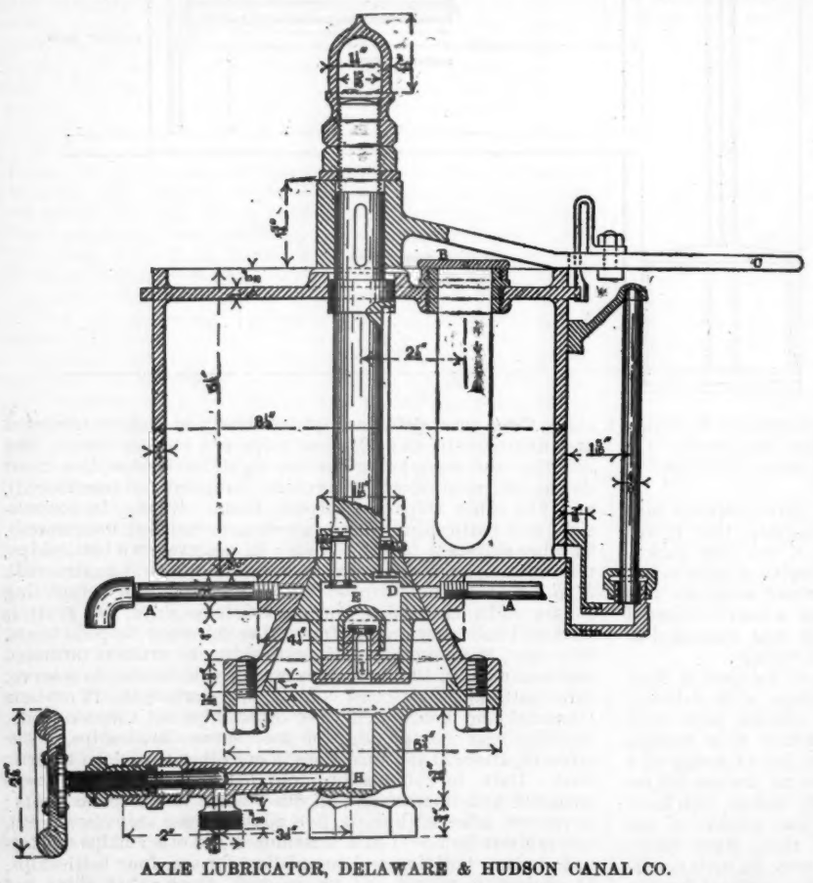
HYDRAULIC ELEVATOR AT PLATTSBURGH DEPOT.

We illustrate a very simple form of hydraulic elevator which is used for a baggage lift at the Plattsburgh Depôt, in which

a single cylinder, whose stroke is multiplied by 2, is used to lift the baggage from the station platform to the baggage-room, and also for lowering the same. The principal feature of the lift is the simplicity of its arrangement, which consists of a cylinder 7 ft. $3\frac{3}{16}$ in. long, bolted to the roof of the baggage room with a piston-rod reaching out and taking hold of a single sheave, over which the wire rope suspending the cage is passed. One end of the rope is fastened to the ceiling of the room, the other passes over a fixed pulley so that it is delivered down the center of the elevator shaft. The general arrangement of piping is clearly shown on the engraving, the valve being located at the top of the shaft and operated by a lever to which two rods are attached, which have a stop for shutting off the water at the top and bottom points of the lift of the cage. One pipe leads into the valve and from it there are two openings to either end of the cylinder with a discharge pipe into the sewer.

APPARATUS FOR OILING LOCOMOTIVE AXLE-BOXES.

There has been a great deal of difficulty experienced by all engine designers and runners of locomotives, that are intended for running long distances at high speeds, in keeping the driving-boxes cool. Arrangements have heretofore been made for introducing a stream of water at the top of the axle-box for cooling off, but this serves merely as a cooler and not as a lubricant, for unless water is supplied continually and in large quantities its lubricating qualities are soon worn away. The instrument which we illustrate, and which has since been put upon the market by M. C. Hammett, Troy, N. Y., was designed by Mr. Cory for use on the through express engines of the Delaware & Hudson Canal Company, and is so arranged that a quantity of oil can be thrown on to any one of the axle-boxes of the engine.



AXLE LUBRICATOR, DELAWARE & HUDSON CANAL CO.

The engraving which we give is a vertical section of the machine, and the prominent part of it consists of a large brass cylinder $8\frac{1}{4}$ in. in diameter and 5 in. deep. The oil is contained in this. From the stand which is cast beneath this reservoir, pipes are led off as at *A A*, running to the box that is to be lubricated. A gauge-glass shown at the right is used to indicate to the engineer the height at which the oil stands in the reservoir. The filling of the reservoir is accomplished by unscrewing the cap *B* and pouring oil into the tube beneath it, which is provided with a strainer, so that all extraneous matter and dirt are removed before being sent to the journals. The handle *C* at the top is keyed to the stem, which passes down through the center of the reservoir and to which the conical plug-valve is attached. This plug-valve has an opening in one side *D*, through which the oil passes to the journal to be lubricated. When it is desired to oil any particular bearing, the handle *C* is turned so that the opening *D* is opposite the opening leading to the particular pipe *A* which is to be used. The oil, in the mean time, has come down through the downward opening valve and filled the space *E*. After the handle has been placed in position the valve handle *F* is turned, admitting steam through the pipe *H*, which passes up through the valve *I*, and entering the chamber *E*, by its pressure closes the valves opening into the reservoir and drives the oil out through the pipe *A* to the bearing upon which it is injected with a squirt.

The apparatus is the result of long-continued experiments and careful adjustment, and the reports of its use on the road are most satisfactory.

THE PHILADELPHIA & READING SHOPS AT READING.

THE shops of the Philadelphia & Reading Railroad, at Reading, Pa., were built many years ago, and the calculation was made at the time of their construction that they were large enough and could be made to have a capacity for doing all of the locomotive repairs required by the road until it should have an ownership of 450 locomotives. The road has outgrown this number by a very considerable amount, and recent reports from the locomotive department show that they have an ownership of between 700 and 800 engines. The shops are therefore called upon to keep in repair a number of locomotives, at least 50 per cent. in excess of that which its builders considered their maximum capacity. The shops occupy two blocks by the side of the main line entering the city of Reading, each 200 ft. × 400 ft., and on the opposite side of the track there is a small space which is covered by the blacksmith and forge shops. Like shops of many other roads which have outgrown their original capacity, the tools are closely crowded together, and there is an accumulation of interesting matter which the new shop, fresh from the hand of the tool makers, does not possess. We intend in the course of the next few issues to illustrate a number of the most interesting of the tools which are to be found in use in these shops. In work of this kind, where every inch of space is of the utmost value, and where tools must be worked to the best possible advantage, it is necessary that the most perfect system should prevail in regard to the handling of the work.

Shortly after the adoption of the piece-work system by the Pennsylvania Road it was also adopted by the Philadelphia & Reading, and largely prevails throughout the shops—in fact, everything is done by piece-work for which arrangements can be made. There is necessarily some day-work in the form of handling of material, as, for example, it is necessary to re-handle locomotive driver wheels and such classes of material several times more than it would be required were better storage space available. But wherever machine work or erecting work is to be done the whole is done by the piece. The pattern shop is about the only exception to this rule. There is a complete set of templates and gauges for standardizing all of the work of the shop, and workmen are not asked or called upon to use their rules except in very rare instances. Most of the gauges are of the well-known types and were nearly all made on the premises, a very few master pieces having been bought from the regular makers. The drawings from which the work is made are nearly all made to the standard size of about $9\frac{1}{2}$ in. × 15 in. These are kept filed in books devoted to the different parts of the engine of which the drawings are made, and are readily filed away in drawers and do not occupy the space, and are made more readily accessible than large and miscellaneous sizes of drawings kept in the ordinary

method in drawers. The drawings are numbered consecutively, regardless of the subject of the illustration, and when a fresh blue print is needed an order is placed upon the blue-print book; the boy removes the drawing from the file, makes a blue print, and returns it to its place. Changes are made upon the original tracings, and all previously made blue prints are recalled from the shops and new ones issued. The blue prints are pasted on sheets of sheet iron and given a coat of shellac in order that they may be kept wiped clean. Sets of drawings are issued to each department so that when an order is sent out the drawing number and blue print number is put upon it, and it is not difficult for the foreman to select the drawing which is needed for the work.

The chemical and testing laboratory is also an important feature of the work, and is modeled after the Pennsylvania laboratory at Altoona, where the head chemist was previously employed. It contains the usual equipment of such a laboratory and one or two novel instruments designed on the premises, which we will illustrate hereafter.

FIG. 1

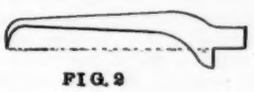


FIG. 2

FIG. 3

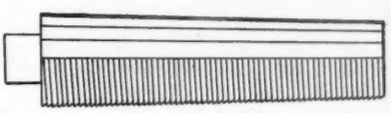


FIG. 4

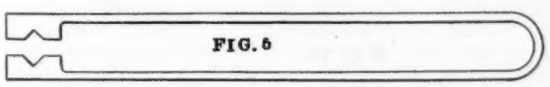


FIG. 5

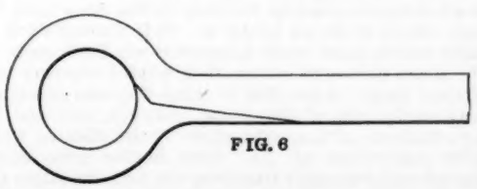


FIG. 6

Referring once more to the system of gauges in use on the road, we would call attention to the method which is used for lining up the pedestals of engines and the gauges used for that purpose. Fig. 1 shows a gauge which is made of the exact size to go between the forward legs of the pedestals of the engine which is to be lined. The point *A* is placed against a cube of a standard thickness, which is, in turn, laid against the leg of the pedestal. Inasmuch as the distance from *A* to *B* is the standard distance which should exist between the liners, it will be seen that the distance which exists when the gauge is in position between the point *B* and the leg of the pedestal will be the thickness of the liner at that point. This distance is then taken, and the liners planed up to proper thickness to it. When the liner is planed and put in position, the wedge with its rough face is bolted up against the opposite leg, and then a gauge, as shown in fig. 2, is used; the point *A* of this gauge is placed against the liner, and the distance from *A* to the point *B* is equal to the dimensions across the box; then, as the point *B* is in a line with the surface at *C*, it is used as a scratch-awl for marking a planing line at the top and bottom of the wedge. This is carefully noted with a prick punch and the planing line drawn. After this is done a check line is marked with a similar gauge one-half inch back from the planing line. The wedge is then taken down, sent to the planer and fitted up. The same system is carried on through all of the legs of the locomotive, and there is, therefore, never any cutting and trying and fitting to see that the wedges and liners are planed up to a proper thickness for the boxes, and the distance between the wheel centers is also accurately preserved. It is only necessary that two opposite faces of one corresponding portion of the pedestal legs should be in line.

In fitting driving-wheels to their axles the same system of boring the wheels and turning the axles to gauges is carried out, and the pressures are made to vary in accordance with the diameter of the wheel. The following notice is posted on the driving-wheel press:

STANDING WHEEL PRESSURES.

Driving-wheels 9 tons per 1 in. diameter of axle.
Truck " 6 " " " " " "
Crank-pins 9 " " " " pin.

Example.—Driving-wheels with 6-in. bore for axle should be put on at a pressure of 6×9 tons $= 54$ tons.

Crank-pins with 4-in. diameter for wheels should be put on at a pressure of 4×9 tons $= 36$ tons.

A comparison of the gauges which are made to do this work shows that for each inch of diameter the bore in the driving-wheel should be about .001 in. less than the diameter of the axle upon which it is to be placed. Ordinarily for road work the tires are bored out straight and shrunk into position by the use of a gas for expanding; but on switching engines, where the tires wear out more rapidly, a taper slip tire is used, the taper being three eighths of an inch in the 5½ in. of width of the tire. These tires are bored out so as to fit the wheel centers accurately, and are held in position by set screws passing through the rim of the wheel and entering the tire from the inside. By slackening off these screws and striking the tire a few blows it is very readily removed.

Especial attention is paid to the testing of the steam gauges for the engines. Very many of the engines have the cab along on the center of the boiler, so that it is necessary to have two gauges, one in the engineer's cab and one back by the tender for the use of the fireman. In order that these gauges may be kept in proper condition, they are inspected very frequently. Formerly it was necessary to remove them both from the engine and take them to the testing gauge in the shops, but lately a new attachment has been placed upon the boiler so that a test gauge, which is itself compared very frequently with the standard test gauge of the shop, can be screwed into this attachment. If the two gauges upon the locomotive register the same pressure as this test gauge they are considered to be correct; if not, they are removed and corrected by the test gauge in the shop until they show the pressures to which they are subjected very accurately.

As it is necessary to do a great deal of boiler work in the erecting shop, it has been found desirable to have rivet-heating furnaces at frequent intervals at the pits over which the engines are run for repairs. There is at one end of the shop a blower supplying a blast to a pipe running down the whole length of the shop, and from which air is drawn for the purpose of supplying the Bunsen burners of the tire-heating apparatus. At nearly every column of the roof bents there is placed a small cast-iron pot lined with fire-brick, into the bottom of which a blast pipe is led from the air pipe running down the shop, so that whenever any riveting work is required on any pit there is a small forge close at hand ready for use for heating rivets or doing any other light blacksmith work that may be required. These pots are about 18 in. in diameter and about 22 in. deep. Their tops are about 30 in. from the floor, and they are so located that they are out of the way of workmen and do not impede the movements of trucks about the shops or in and out of the gangways. It is a very great convenience, and is very much neater than the ordinary portable forge, which must be carried to the point at which the work is to be done.

All of the boiler studs which are put into the boilers are made with a taper of three-quarters of an inch to the foot, and taps are so arranged that a workman cuts the thread to the exact depth necessary for the screwing-in of the stud without leaving any threads exposed. This is done by placing a check nut upon the tap and screwing it in until this nut comes down hard against the surface of the plate. The workman then knows that he has gone in to the proper depth, and when the thread is cut upon the threading machine the thread is so cut by the die that it will exactly fill this hole.

In connection with this matter of tapping out holes in the boiler we illustrate a special reamer which was designed and made at this shop for reaming out holes which have been chipped in a boiler. It is very well known how difficult it is to get a half round reamer to work well in a roughly chipped hole. No matter how careful the workman may be in its manipulation, before the hole is thoroughly reamed out and in condition for a tap the reamer is sure to catch very many

times, and the probability of breaking off the edges is very great. With the reamer shown this difficulty is entirely avoided. The hole is laid out in the usual manner, and two cross holes cut straight with a cape chisel. The corners are then trimmed off and it is ready for the work of the reamer. Fig. 8 gives a cross section and fig. 4 a side elevation. The smooth part of the reamer is cut with a thread, shaped, as shown on the side elevation, of about 12 threads to the inch. The cutting portion of the reamer occupies the other half of the circle. This device will square itself in the hole if it is handled with any sort of care, and it is not necessary to hammer it or crowd it in any way, as the thread on the smooth portion is sufficient to draw it down into the hole. There is no danger of its crowding to one side or catching, as there are ample cutting surfaces, and it has no tendency to work toward the point of least resistance, as will inevitably be the case with the ordinary half reamer.

Another handy tool for use in the blacksmith shop is shown in fig. 5, which is intended for squaring up the heads of stay bolts previous to the cutting of the threads. As it is somewhat expensive to make a set of dies for use under a steam hammer, this little device was designed. It consists of two blocks about 1¼ in. wide and 3¼ in. long, with the square notches cut in them, as shown by the engraving. These are welded to a strip of steel ½ in. thick and 1½ in. wide bent into a U form, having a depth of about 30 in. The natural position of the device is open, throwing the dies up to about 1 in. apart. The hammerman holds the end of the U in one hand, and manipulates the hammer lever with the other. The blacksmith takes the heated stay-bolt and places it in the dies, which are struck a sharp blow and brought together. As the hammerhead rises the dies swing apart and enable the blacksmith to turn his work as much as may be required. The same principle is used in making tools for other purposes, such as putting of rings on to pins, etc.

Fig. 6 gives a detail of a scarf which is used for the weld that is made in hangers like those used for coal scales, etc. This scarf produces not only a very strong weld, but one which gives a smooth surface on the inside of the hole. It is, perhaps, a trifle more expensive than a plain flat scarf would be, but it holds very much better and the work is smoother. In the blacksmith shop also the bushings which are used for the spring hanger pins are made to their proper internal diameter over the mandrils, so that they do not require any other finishing for the entrance of the pins. They are driven over a solid mandril in the machine shop and turned off to their proper diameter. The pins are also formed in the dies, so that there is no necessity for any machine work being done upon them.

Any one who is at all sensitive to the effects of sulphur will at once notice the difference of the atmosphere of the Reading

Fig. 7.

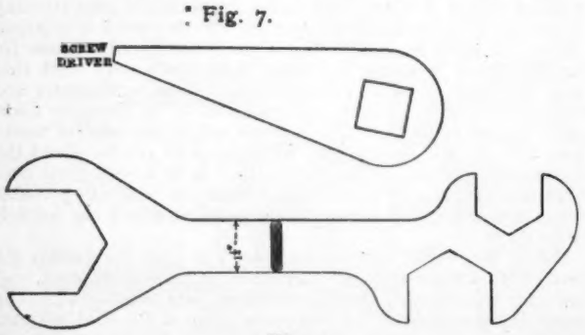


Fig. 8.

blacksmith shop and that of the ordinary shops. The atmosphere is almost as clear as it is out of doors, and even the most sensitive can spend an indefinite length of time there without being troubled with the disagreeable coughing caused by sulphur fumes. The reason for this lies in the use of a very close hood arranged over the forge, which is of special design, and which we will illustrate later, by which the draft is so maintained that all of the fumes and products of combustion from the coal are carried up the stack and into the atmosphere. This is perhaps a small matter, and may not affect the amount of work done by the blacksmiths, who soon become accustomed to sulphur fumes, but it certainly is a very attractive feature to visitors who are at all sensitive to the ordinary fumes from blacksmith coal. A great deal of die work is done in the

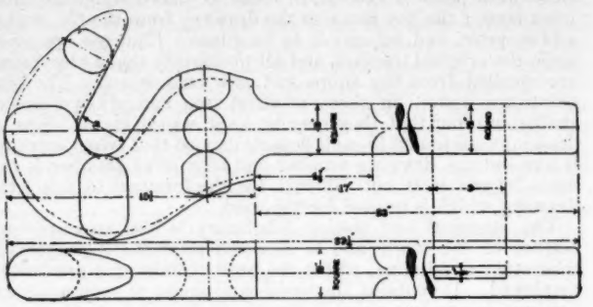


Fig 9.

blacksmith shop, dies being made for almost all of the standard sized wrenches as well as for some of the heavier work on cars and locomotives.

We give in figs. 7 and 8 two samples of wrenches which are made under the die from spring steel. Two sets of dies are required for this work. The first is simply a cutting die for shaping the material, and the second is used for squeezing it

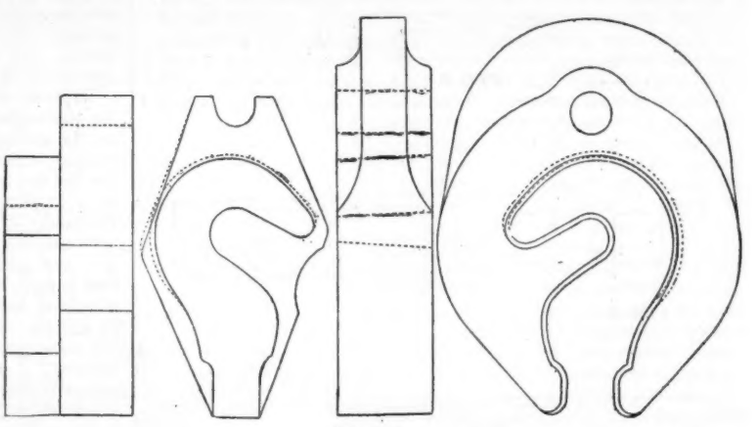


Fig. 10.

out and rounding the edges. Probably the best piece of die work which is done in the shop is the draw-hook for the coal cars, which is shown in fig. 9. This draw-hook is made from slabs which have been hammered up from scrap iron under the steam hammer, and are then welded together into a spade-shaped form. After this is done they are reheated, the keyway in the tail of the shank punched, and the hook itself punched out of the solid plate by the dies, of which we also give engravings, fig. 10. Then in the same heat they are placed under another stamping die and the edges of the hook rounded, so that when they leave the hammer they are all ready for use under the cars. This is very much more rapid work, and the company claim that a stronger hook is made than in the old method of drawing out and turning up the hook, as is usually done. Of course the manufacture of a hook in this way can only be done economically when large quantities are used; but inasmuch as the Reading Road has several thousand cars equipped with these hook draw-bars, and as the demand for them for repairs is constant, there is work enough to keep one hammer and a furnace busy nearly all of the time in getting them out.

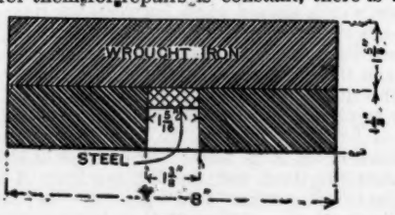


Fig. 11.

The other die work which is done in the shop consists of keys for springs, which are punched and rounded out in one heat, catches for switch reverse levers, springs, cotters, and other work of the same type. Fig. 11 shows a cross-section of the die which is used for forming the wrenches, giving the cross dimensions of the same. The steel piece that does the cutting is so arranged that it can be replaced when worn out, and also the clearance is such that the die can be repaired several times before it is rendered entirely useless.

FRENCH CORRIDOR TRAINS.

We have frequently adverted to the irrational mode of building intercommunication carriages. Although it represents a well-meant attempt to combine the advantages of American and European rolling stock, it nevertheless constitutes a constant source of danger, for an equal distribution of the weight on both sides is impossible. This applies more especially to corridor carriages running on six wheels. Several carriages of this type have been built lately for English lines. It is a puzzle to find out why our railway engineers did not adhere to the use of bogies for these cars.

This system of corridor cars is open to criticism; but the one we are going to describe is decidedly the worst combination that could be imagined.

In 1889 the Paris-Lyons-Mediterranean Railway built and exhibited intercommunication cars on the corridor system, running on four-wheel bogies. The corridor did not extend over the full length of the train; it had a Z shape—that is to say, the corridor extends first up the middle of the car, and then opens into a transverse passage, to run afterward along the other half, and on the other side of the carriage.

It does not seem that this design has been successful, for the Paris-Lyons-Mediterranean Company have recently put on their lines six-wheel corridor carriages in which the corridors are all on one side. They are only first and second-class, but we hear that the third-class are also being built. There is, however, a great difference between these carriages and those recently built in this country. The innovation consists in retaining the doors as they are in the ordinary compartment system. In other words, there are in each carriage four sets of doors: The external ones on each side of the carriages, those of the compartments opening on the corridor, and finally those at each end of the carriage. In other words, access to the compartments is obtained from either side of the carriages, the end doors being only a means of communication between one carriage and the others. For this purpose the end platforms of the carriages are connected by a small bridge, covered with a leather awning, which is formed like a concertina, so as to follow the variations of distance between the cars while the train is running on curves, etc. The same arrangement is used in the German corridor trains.

This design at first sight presents some advantages over the usual corridor trains, but we shall see that these are more apparent than real. The retaining of side doors of the antiquated compartment system will, indeed, facilitate the ingress and egress of passengers, while the end doors enable them to go from one carriage to another, or to the dining car, if there be one forming part of the train. But this multiplicity of doors makes the carriages rather uncomfortable; it weakens the body, and as the outer doors necessarily open outward, the width of the body had to be reduced; it cannot be 10 ft., as in the German corridor carriages. The width of the corridor is also very much reduced. These cars will, however, be suitable for running over the French Northern and the Swiss railways, the boundary line of clear headway of these railways being somewhat smaller than the German standard one.

The first-class carriages contain 4 compartments and 25 seats; the second-class has 5 compartments and 41 seats; the odd seat in both cases being provided at one end of the car, while the other end is fitted with a lavatory and water-closet.

The wheel base of the first-class is 22 ft. 7½ in., that of the second class 23 ft. 8⅝ in. full. No special device is employed to facilitate the inscription of the end axles in curves. The middle axle has a side play of about 1¼ in. in axle guards, and the end axle the usual play of $\frac{3}{16}$ in., as in ordinary carriages. The maximum width of the carriages is 9 ft. 5½ in. full.

Each first class compartment contains six places covered with gray cloth; each second-class compartment contains eight places covered with blue cloth. The first-class seats are also provided with springs, and a system of jointed levers allows of the seats being pulled forward so as to render them more comfortable for night journeys. The internal woodwork is of mahogany for the first-class and pitch pine for the second-class.

The lighting is effected by oil gas, the reservoirs being fixed on the roof of the carriage and extending over its whole length.

No improved method of car heating has been adopted; this company seems to stick to the antiquated hot-water foot-warmer. The renewal of these during the journey entails the same disadvantages as those prevalent with the compartment system.

No special means has been provided to lessen vibrations. The body does not rest directly on the wrought iron underframe; pads of india-rubber are inserted between the first class bodies and the sole bars. In the second-class the pads are of wood. (Why this distinction?) The springs are 8 ft 2 in. long, and the plates which compose them are 3½ in. wide × ⅜ in. thick. We fear these springs will be too stiff.

The wheels, 3 ft. ⅛ in. bare, in diameter, are known as Arbel Patent Anti-Dust wheels. They are made of wrought iron, but the space between each two spokes is fitted externally with a web, which causes the wheels to look like plain disk wheels. They are very strong, and do not churn the air as spoke wheels do. The journals are 3½ in. in diameter, and 7.21 in. long.

We will conclude with the following particulars:

	1st Class.	2d Class.
Length over buffers.....	38 ft. 8½ in.	40 ft. ⅜ in. full
" of body.....	34 " 5.4 "	35 " 9 " "
Internal height.....	9 " 5½ "	9 " 5½ "
Weight, empty.....	15.84 tons	15.80 tons
Dead weight per passenger..	12.65 cwts.	7.7 cwts.

The carriages are also fitted with the Westinghouse system of pneumatic intercommunication, whereby a passenger can in a case of emergency put the brake partly on without, however, stopping the train, thereby warning the driver that something is wrong in the train. This system and that of Wanger are largely adopted in France, and are far superior to electric and other systems of intercommunication, which are not connected with the continuous brake.—*The Railway Press.*

THE HANDLING OF FUEL ON THE FRENCH, ENGLISH AND BELGIAN RAILWAYS.*

By M. Jullian.

The fuel burned by locomotive engines represents a considerable proportion of the expense of the mechanical department, and one which it is very desirable should be reduced as much as possible. These expenses may be divided into three heads:

1. Purchase of the coal.
2. Transportation to the points of consumption.
3. The different methods which are used to place the coal when it has reached its distributing point on the cars into the tenders on the locomotive engines.

The subject of the devices which shall be used for the conveyance of the coal from the cars to the tenders at the stations or yards where this is done will be the subject of this paper. This manipulation includes the following operations:

1. Shunting of the loaded cars upon the tracks of the yard.
2. Unloading of these cars either into heaps or into the lorries which are used for carrying the coal to the tenders.
3. The loading of the tenders by means of these lorries, which are filled either directly from the car or from the heaps.

The shunting of the cars is almost entirely engine work. In every yard the service is always so regulated that the cars can be hauled by locomotive engines upon the tracks of the coaling station and as convenient as possible to the place of unloading. But the brakeman or workmen in the yard are always obliged to do a portion of this work to a greater or less extent by pushing the cars to the exact point of unloading. This last operation is very expensive, although it does not generally figure in the expense account. But it is none the less certain that whether the method adopted in the yard is piece work or done by the day, it is necessary to take this supplementary work into account both in the price paid and in the number of workmen employed. It is, therefore, of the utmost importance when the arrangements of the tracks of a yard are taken into consideration, to so locate them that the movements of the cars shall be as easy as they can be made, and shall be carried on as far as possible with engines.

Before entering into the details of these different operations, it is well to note how they can be simplified every time it is necessary to take coal from the car and put it directly into the tender; as we shall see further on, the ease of handling will in this case be diminished by one half. But it is not always possible to work in this way; for example, when the coals used only make a good fuel when mixed with others in proportions which have been established by experience, or when the irregularity of shipments compels the holding of considerable quantity in stock, necessitating the handling for filling up the storage place and removing it from these same places when shipments are stopped. We therefore see how important the regularity in shipments are from the standpoint of expense of handling.

The different systems of handling used to carry the fuel from the cars to the tenders, whether or not by way of storage heaps, may be divided into two classes:

* *Revue Générale des Chemins de Fer.*

(*A*) Handling effected without the use of fuel platforms or coal tips. The coal being placed in lorries, baskets or bins, and conveyed to the tender either by hand or mechanical appliances.

(*B*) Handling which is accomplished by means of an intermediate discharge into baskets or bins placed upon a fuel platform or coal tip, whence the fuel is then taken to be dumped into the tenders, these different operations being made as before indicated by men or mechanical power.

It is hardly necessary to say that in these two systems, if it is required to make a preliminary unloading on to heaps, that this unloading is always done without the intervention of a coal pit either by hand or mechanically. The object of this paper being to study mechanical means of handling, no attention will be paid to those where men do all of the work. Therefore, in order to show the differences which these operations present either in cars or in the time required, it is essential to report on each one of them.

COMPARISON OF EXPENSE FOR HANDLING FUEL.

In 1885, last year when all the handling was done by hand.
In 1889, year when mechanical handling was in operation at La Chapelle, Fives, La Plaine, Somain, Amiens and Tergnier.

The Depot.	Tonnage of Coal delivered to Engines.		Difference between that and 1885.		Expense of Handling.		Difference between that and 1885.		Cost of Handling one ton of Coal.		Difference in per cent less than in 1885.
	1885.	1889.	More.	Less.	1885.	1889.	More.	Less.	1885.	1889.	
	Tons.	Tons.	Tons.	Tons.	$	$	$	$	$	$	
La Chapelle	48,687.65	58,512.45	9,824.80	.....	9,870 57	7,460.62	.....	2,409.96	203.73	127.49	35.4
La Plaine	29,130.00	32,913 70	3 783.70	.....	4,588.65	2,411.96	.....	1,266.69	157.51	100.79	35.9
Fives	43,851.00	57,100.50	13,249.50	.....	6,910.45	5,216.79	.....	1,693.66	157.51	91.20	42.0
Somain	27,319.75	31,698.75	4,379.00	.....	3,978.14	2,128.74	.....	1,849 40	145 35	67.07	53.8
Amiens	48,429.50	49,972.90	1,543.40	.....	9,625.84	5,689.42	.....	3,936.22	198.84	*113.81	42.7
Tergnier	44,519.50	38,797.45	.....	5,722 05	6,634.10	4,533.39	.....	2,099.70	148.96	117.04	21.5
Total of the other stations	174,285.50	237,876.45	43,590.95	.....	29,758.49	32,222.87	1,464.38	.....	176.70	147.82	16.3
	416,222.90	486,872.20	76,371.35	5,722.05	72,366.25	60,574.99	1,464.38	13,255.63	173.47	123.88	28.6
	+70,649.30 tons.		+70,649.30 tons.		—11,791.25		11,791.25		49.59		—28.6

Average { 42.0 / 53.8 / 42.7 / 21.5

* Figures for 1888.

HANDLING DONE WITHOUT THE USE OF A COAL TIP.

Transferring by Hand.—With this system the fuel taken from the car is thrown into baskets holding about 88 lbs., a weight which has been recognized by experience as that best adapted for the good utilization of the strength of a man, and these baskets are loaded upon the shoulders of the workman and are carried to a definite point of unloading, whether it be the heap, the tender, or the tip. This system has the disadvantage of being expensive and very slow, since men with a load of 88 lbs. have to traverse a greater or less distance and raise themselves with their weight to the point where the unloading must be done. Thus, when they are used for loading tenders it is necessary to increase the number of workmen, and this almost always increases the expense of unloading. The loading of a ton of coal into a tender with this system requires at least six men working for from three to four minutes, as the case may be, and costs $.12.

Transferring Mechanically.—This system is only used in France by the Northern and Eastern Railway Companies, and is still, in the case of the latter, in a period of probation, and only installed at the Chaumont Depot. The two systems are, furthermore, slightly different. That of the Northern admits the loading at any point of the yard; that of the Eastern Road, on the other hand, has only one point of loading.

Arrangements of the Northern Railway Company.—In the June, 1888, issue of the *Revue Générale des Chemins de Fer*, there was a paper giving very complete details of the conditions which the engineers of the Northern Company intended to fulfil for the unloading into heaps and the loading of tenders, and the methods which they had adopted; these methods consist in transporting the fuel from one point of the yard to another by means of tubs and steam traveling cranes. All the reports in regard to the organization of the yards and the types of material used will be found in the paper referred to. It is only necessary to add, to complete it, the expense of the various methods of handling with the crane, and to show the advantages and disadvantages of the method as adopted by the Northern Railway Company.

The average cost is $.0475 per ton for handling, which includes the unloading from the cars into heaps or into the tenders, or the loading of the tenders with the fuel taken from heaps. As almost all the fuel put into the tender was first unloaded into the heaps, we can say that every ton of coal delivered to the tender costs $.095 for handling, to which must be added the expense of operating and maintaining the crane. The table which is given below and which was furnished by M. de Bousquet, Engineer-in-Chief of locomotives and rolling stock, gives a very exact idea of the actual cost of handling in the different yards of the Northern Road, showing a comparison with the expense in 1885, when the mechanical devices were not in use, as well as the time and expense saved by the methods to which we are devoting our attention:

To complete the report, the expense of maintenance and operation of the crane must be added, and this is given in the following table:

COMPARISON OF THE EXPENSE OF OPERATING AND MAINTAINING THE CRANES, AND THE EXPENSE PER TON FOR HANDLING IN 1888 AND 1889.

Depots.	Tonnage of Coal Distributed to Engines.		Expense of Operating and Maintaining Crane.		Expense per ton Handled.	
	1888.	1889.	1888.	1889.	1888.	1889.
	Tons.	Tons.	$	$	$	$
La Chapelle	56,502.20	58,512.45	1,733.54	1,837.28	30.59	31.35
La Plaine	30,384.10	32,913.70	782.77	733.29	25.65	27.36
Fives	54,423.40	57,100.50	841.21	1,213 84	15.39	21.09
Somain	31,611.50	31,698.75	546 40	554.01	17.86	17.29
Amiens	49,972.90	47,806.40	1,059.21	1.092.20	21.09	22.80
Tergnier*	17,403.50	38,797.45	479.72	1,039.93	17.17	26.79

The method adopted by the Northern Railway has very appreciable advantages in unloading into heaps when we merely consider the rapidity and expense of operation. The correct reports given in M. Flaman's paper show that unloading of a car of 10 tons capacity into a heap can be accomplished in 25 minutes, and involves an expense of from $.589 to $.5985, including the expense of maintaining and operating the crane. Now the same work, when done in baskets, requires at least 40 minutes, and costs on an average about $1.01, including the expense of maintaining the baskets. The advantages of this method are more evident when we consider the good mixtures which can be made by heaping up. It may be remarked, in this connection, that the yards on receiving coal of very different qualities can only produce a good fuel when they are thoroughly mixed, as at Amiens, Somain and Lille, this work being done with a shovel as far as possible, the crane only being employed in cases where haste is required.

The crane will load a ton of coal on to the tender in 2½ minutes or four tons in 10 minutes, and costs about $.06. The same work, when done with baskets located in advance on a platform, would not take very much longer, and it would be, it is true, but very slightly more expensive. The use of this

* For engines, the distribution given for 1888 is that of the second half year, the only portion of the year where mechanical distribution of the coal was in operation.

method is applicable at stations which have, as almost all those of the Northern Railway Company have, several entering tracks which are located between the coal piles or the sidings for the cars; there is, therefore, no disadvantage in having engines come in on the track which is used by the crane. On the other hand, at those stations where the heap of coal is scattered over the whole extent of the yard it cannot be traversed or served by tracks which can be used for engines, so that the use of the crane is not applicable to loading upon the tender. To conclude the consideration of the methods of the Northern Road, it only remains to speak of the night work and the quantity of coal handled.

Night work is especially easy to accomplish by means of the crane; it is sufficient to place a brilliant light on a post—a locomotive headlight, for example—so that the manipulator of the crane can handle the tubs and locate them expeditiously and safely. By placing another light of the same brilliancy near the workmen who are filling the tubs, the whole work of filling and unloading can be carried on in the best possible manner.

It is difficult to determine the number of tubs delivered by the crane by taking the number of turns made by the hoisting shaft; on the other hand, the use of tubs of different capacities, which may even be filled to a greater or less extent, may so complicate matters that the number of turns made by the hoisting shaft, even admitting that it is proportional to the number of tubs hoisted, would not bear a proper relationship to the quantity of coal handled. Under these circumstances it is necessary to refer to the note-book of the craneman to learn the number of tubs of each capacity which has been lifted during the day, and to the reports of the inspector who has charge of the loading of the tubs. It is probable that the oversight thus exercised may give satisfactory results where large quantities are handled and where we can take the average capacity of the tub as a basis of our calculations. But it may be permitted to ask whether it is sufficient to determine with perfect accuracy the amount of fuel delivered to each engine which has been loaded during the day.

Arrangements of the Eastern Railway Company.—The use of mechanical methods for handling fuel at other coaling stations was only begun about two years ago, so that the system which we are about to describe is one of recent installation and only exists at a single station—that of Chaumont—where it is in full operation.

The principle which seems to have been adopted is the following: on account of the mixing which must be done, all the fuel is unloaded into heaps as in the Northern Railway. The only exception is in the case of briquettes, which are loaded from the car into the tender as far as it is possible. The coal piles are bounded on one side by a track or two parallel tracks for sorting out or switching cars, and on the other side by three parallel tracks, the nearest one to the coal piles being used for the movements of the crane following the movement of the wagons in unloading, and the furthest one for the movement of engines. The arrangements of the tracks at the Chaumont Depot are those given in fig. 1. At this depot the yard has been doubled, and its ranges of coal heaps have been made on either side of the tracks of the cranes, cars and engines; on one side there are the heaps which are being built up, and on the other those from which supplies are being drawn. With this arrangement they have found it necessary to lay a fourth track for unloading cars, as will be noted further on.

The Chaumont Station distributes 80 tons of coal, including briquettes, daily. The coal is always divided into three distinct piles: one for high-speed passenger engines, the other for engines hauling local and accommodation passenger trains, the third for freight engines. These piles are composed of mixtures made according to the instructions of the head of motive power department and according to the shipments as they arrive.

There are always six piles: three for distributing on one side and three being built up on the other; the size of the piles is therefore proportional to the amount of fuel for distribution which they contain. The work in the yard is regularly done by six men—a crane man and five laborers. It is often necessary, nevertheless, to supplement them by extra help if the receipts are too great.

The plant includes a crane of one ton capacity, having a swing of 26 ft. 3 in. and a height of lift of 9 ft. 10 in. This crane was not built for this especial purpose, but was in use in one of the shops and was utilized for this purpose; five Decauville coal tubs of 1,100 lbs. capacity are used both for loading and unloading; five Decauville lorries whose holders have been removed and replaced by wooden chock blocks upon which the tubs can be placed and carried to any point whatever of the yard. The operations when working are as follows:

Unloading on to the Coal Heaps.—All the unloading of the small pieces into heaps is done with a shovel; the crane is only employed for unloading cars containing large lump coal. To unload they proceed as follows:

Suppose that heap No. 1 is for distribution and No. 2 is being built up, the crane is located on track 22 and two cars

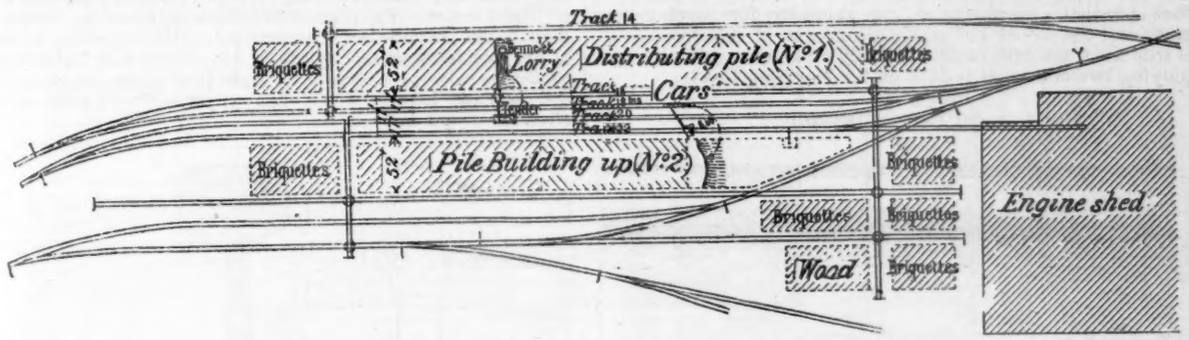


FIG. 1.—CHAUMONT COALING STATION, EASTERN RAILWAY OF FRANCE.

are switched in upon track 18 in the most favorable position for unloading. Two men are stationed on each car with a tub, and the duties of the fifth man are to take care of the unloading of the tub. The rest of the working is the same as upon the Northern Road—that is, the crane lifts a fuel tub from each car in succession, carries it to the coal heap and empties it there and carries it back to the car. The unloading of the two cars in this case is the most favorable possible, but occupies a little longer time than on the Northern Road, or from five to six minutes, on account of the capacity of the tubs, which only contain one-half ton. But a more unfavorable condition of affairs frequently occurs when it is necessary to unload the fuel at a point more than 26 ft. from the crane; in this case it is necessary to use lorries. The crane deposits the tub upon the framing of these lorries, and a man pushes them to the point where they are to be unloaded. The time occupied in this way is very frequently doubled.

For loading on the tender the crane is moved on to track 18 and the engines are run in on track 20, stopping within the radius of the action of the crane. This loading is done in exactly the same manner as on the Northern Road. The time occupied is practically the same, and it requires about 2¼ minutes to load a ton of coal on the tender, except in cases where it is necessary to use the lorries to go after the fuel and bring it within reach of the crane; but such cases as these are rare, for the men bring the coal within reach with shovels during that time of the day when there is nothing else to do. The briquettes are loaded by hand, so that they may not be broken.

We can see, then, that in its general arrangement this Eastern yard does not differ practically from those of the Northern Road; for unloading cars the crane does not stand upon the same track as the cars. This is because it is essential that the crane should be able to move freely from track 22 to 18 and inversely accordingly as there is a car to unload or an engine to coal; it is for this reason that they have laid a fourth track for storing the cars. Practically, however, the crane is very rarely moved, for they only use it for unloading when there are long intervals between the successive coaling of two locomotives. As for the supervision of the work it is more imperfect than on the Northern Road, since the crane has no revolu-

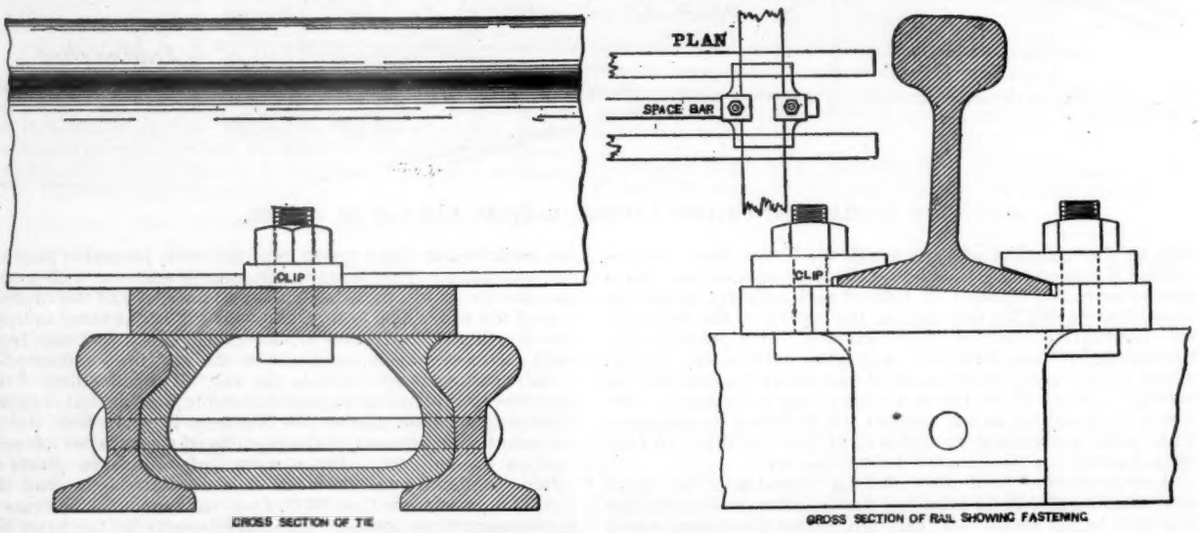
tion counter. Every time that the depot master or the gang foreman wishes to verify the work, a tub is taken at haphazard and placed on the scales, just as they would do if they were working with baskets. Piece work has not yet been established at the Chaumont Station, so that it cannot be determined as yet whether there is any economy resulting from this new system. The gang has been diminished by two men since the plant was installed, and the workmen are paid but $ 80 per day. Yet the saving which is effected may be estimated from the following figures: In 1886 the yard delivered 31,069 tons of coal to locomotives, and the expense of doing this was $2,574.69, which corresponds to an expense of $.08 per ton, to which $.004 per ton must be added for the maintenance and repairs of baskets and other miscellaneous expense, giving a total of $.084 per ton. In 1889, 29,591 tons were delivered to locomotives, and the expense for this work was $2,067.66, which corresponds to an expense of $.07, to which must be added $.01 for the expense of operation and maintaining the crane, or $.08 in all.

We therefore see that the saving is not very great; and it is solely on account of the slight amount of work which is done at this depot that permitted this loading with baskets to be accomplished with such a small gang, and, consequently, at such slight expense. The system adopted by the Eastern Road has all the disadvantages of the Northern. It requires a number of tracks for the engines. There is no guarantee that the mixture of the coals is well done in the coal piles, and it does not permit of an easy supervision over the quantity of fuel handled. Furthermore, the necessity for moving the crane and the use of lorries are also marks of inferiority. It is true that the first could be easily done away with by employing two cranes, as is done on the Northern Road.

(TO BE CONTINUED.)

wedges, which give the rail an inclination of one in twenty, prevent all contact of metallic surface, which is an advantage from the standpoint of the preservation of the track material and the smoothness of running. The rails, which have a length of 39 ft. 4.5 in. and weigh 89 lbs. per yard, rest upon 16 ties. They are laid with suspended joints and broken. A hundred of these ties have been in use for about eight years, and have given satisfactory results.

Metallic Tie used on the Taviers & Embresin Railway in Belgium.—The accompanying engraving shows the metallic track which is used on the Taviers & Embresin Railway in Belgium. This railway, which has a length of 6.2 miles, starts from the Noville-Taviers Station of the Belgian State Railway, running from Namur to Ramillies, and is of a purely local interest; it is a single track, with the standard gauge of 2 ft. 4 in. between the inside edges of the rails. These are of the Vignole type, and have a length of 29 ft. 6.3 in., weighing 28 lbs. to the yard; each rail rests upon four ties which weigh 46.3 lbs. each, and it has supported joints. The ballast consists of ashes and broken stone, with a depth of 10 in. in thickness. The inclinations of the cross section of the Taviers & Embresin Railway do not exceed 1½ per cent., and the up-and-down grades are separated from each other by level places of at least 164 ft. in length. The sharpest curves have a radius of not less than 328 ft. on the main line, and where there are two curves following each other in the opposite directions there is a straight line of at least 164 ft. in length between the two. The daily number of trains running over the road is 13 passenger and 6 freight trains. The maximum authorized speed is miles an hour. The metallic ties are composed, as the engraving shows, of old iron rails cut to a length of 4 ft. 11 in. and fastened together in pairs by means of wrought-iron chairs weighing 8.8 lbs. each and held by rivets, their upper surface having an inclination of one in twenty.



METALLIC TIE USED ON THE TAVIERS & EMBRESIN RAILWAY, BELGIUM.

TESTS OF METALLIC TIES ON THE EASTERN RAILWAY OF FRANCE.

By G. Braet.

The Guillaume Tie.—The Eastern Railway of France, which in 1865 made some experiments with different types of metallic ties, paying especial attention to the Vautherin form, has recently resumed its experiments with a new type, in which it is sought to obtain a means of avoiding the disadvantages which were manifested in the first attempts.

This new tie, invented by M. Guillaume, and which we will describe, is shown in the accompanying engraving; its transverse section is in the form of a trough resting upon a plane surface, and it is entirely embedded in the ballast. The ends are turned down and oppose the movements due to the side thrust or the hindrance which the ballast can offer in the direction of least resistance. The rail attachments are made of movable lugs of cast steel, which are simply caught by their two tenons into the body of the tie. Finally, the holding down of the rails against these lugs is obtained by driving wooden wedges made of creosoted elm tightly in between the upper surface of the tie and the flange of the rails. These

The rails are held to these chairs by means of clips and bolts. On curves the rails rest on nine ties instead of four, and under the supporting surface of the chair there are stay-bolts for maintaining the distance between the two lines of rails constant.

This track was laid in 1887, and, according to the reports which have been furnished me by the company, the results obtained up to the present have been very satisfactory from the standpoint of firmness of the seating of the track and from that of the expense of maintenance, which has been almost nothing since the substitution of these metallic ties for the wooden which were previously used.

LEAD-PENCILS.

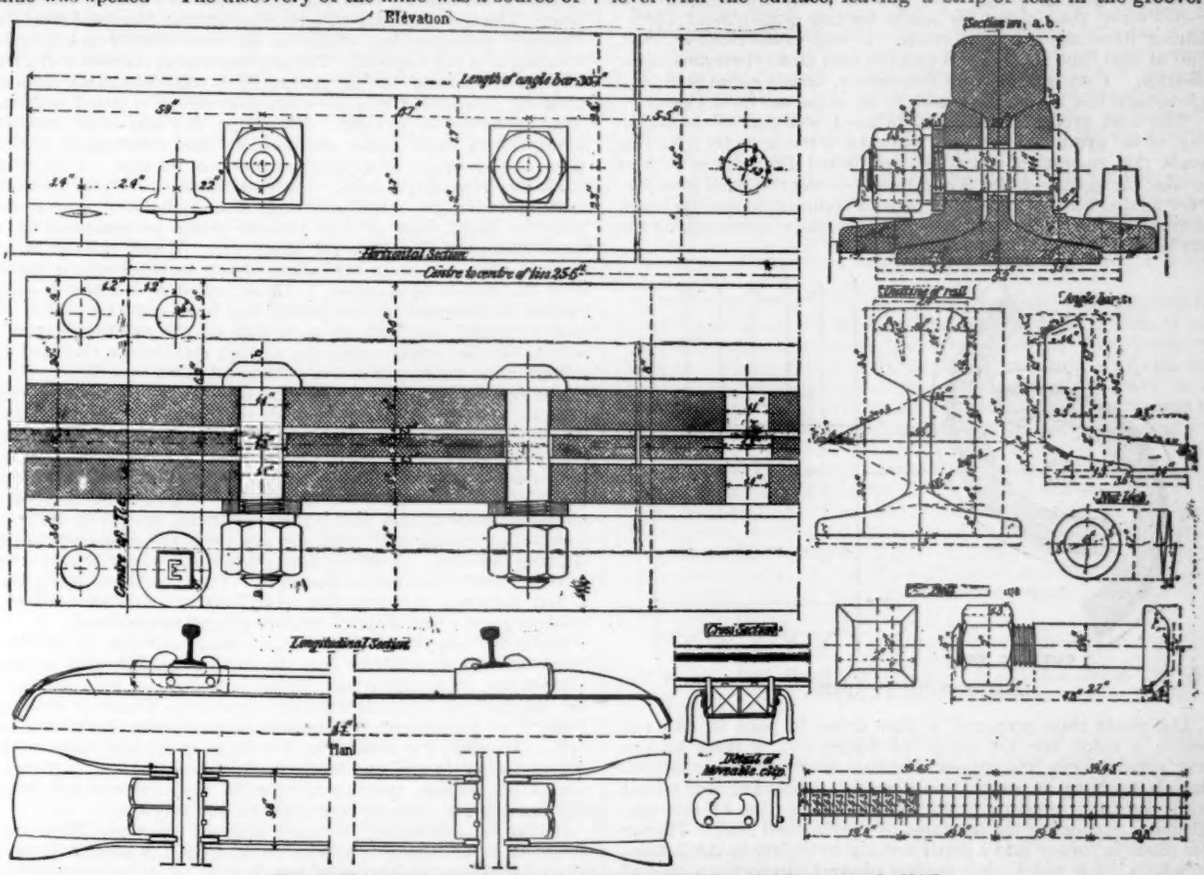
All engineers use black lead-pencils, yet very few know precisely how they are made. They take them as a matter of course, and so long as they are good they care very little about where they come from or the manner of their production; and yet the manufacture of black lead—plumbago—pencils involves the use of ingenious if simple machinery, and presents many points of much interest. A short description of the

process as carried on in Cumberland in the present day will not be out of place in our pages.

When the first black lead-pencil was made is unknown. That is a secret locked up in the treasure house of history. In a book on fossils by one Conrad Gesner, of Zurich, written in the year 1565, reference is made to an article bearing strong resemblance to a black lead-pencil. About this date was discovered the famous Cumberland "lead" mine at Borrowdale, and in all probability Conrad Gesner referred to one of the first specimens made in that district. It has been asserted that a manuscript of the thirteenth century by Theophilus shows signs of having been ruled with black lead; but as the fact is not well established, we may accept the date of Gesner's book as the probable birth time of pencils.

It is said that plumbago was first found on the roads in Cumberland. The curious black stuff that made marks so easily attracted attention. It was searched for and found in stones used for making fences Cumberland fashion at the roadside. Then inquiry was pushed further, and finally the Borrowdale mine was opened The discovery of the mine was a source of considerable wealth to the owners, as the plumbago was found in such a pure state and in such large pieces that it had merely to be cut into long narrow bars by means of fine saws and be immediately mounted in wooden cases. The loss, of course, was exceedingly great, and as small specimens were practically useless, the surface lead was rapidly exhausted. The mine was pushed further, and certain curious restrictions were put on its working. Once a year it was opened for a short time, and as much taken out as would suffice to meet the demand. But these restrictions were useless; plumbago was found elsewhere, and it can now be imported from Ceylon and sold for less money than the Borrowdale lead costs. Indeed, it is doubtful if more than an insignificant quantity exists in Borrowdale. Next, as it had become evident that there was a great demand for lead-pencils, both on the Continent and in England, inventors sought to discover a means of solidifying the waste powder into lumps from which the bars could be cut. To Mr. Brockedon in England, and M. Conté in France, are due the honor of the discovery of the two methods which obtained. M. Conté's system is still in use, and indeed very soon after its publication superseded the English system.

Mr. Brockedon, having reduced the waste plumbago to a very fine powder, tried to conglomerate it into a solid homogeneous block by great pressure. All his attempts were frustrated by the breakdown of the machines under the required pressure. The air in the powder prevented cohesion. He then hit on the idea of conducting the same operation *in vacuo*. As it was found impossible to introduce the compressing machinery under the bell of the air-pump, he adopted the following ingenious method: The powdered graphite was formed into a cake under a moderate pressure; over its entire surface was then glued thin paper; in one side was pierced a small hole. The block was then introduced into the exhausting chamber, and all the air and moisture removed. While still in the vacuum the small hole was covered by an adhesive wafer. The block was withdrawn and subjected to a regulated pressure, and an artificial block of graphite was produced. A number of these blocks were then glued to a thin board. The larger block this formed was cut into thin sheets, which were passed to the "fitter." This operative had before him a number of grooved slips of cedar or juniper wood, prepared to form the body of the pencil. Into the groove he inserted the edge of one of the thin graphite sheets, which he then snapped off level with the surface, leaving a strip of lead in the groove.



THE GUILLAUME TIE USED ON THE EASTERN RAILWAY OF FRANCE.

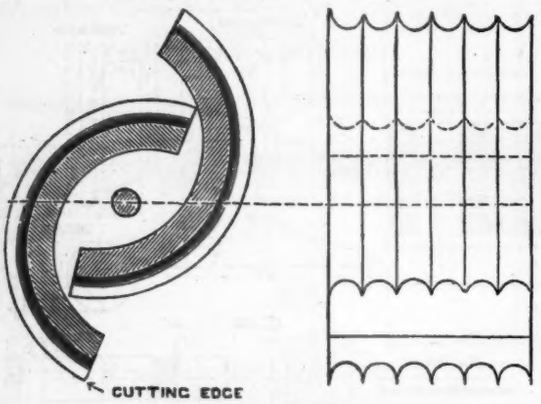
Another operative glued the other portion of the pencil to the first piece, thus completely encasing the lead. In succeeding operations the pencil was rounded and polished.

The method devised by M. Conté in 1795 of utilizing the waste plumbago obtains, as we have said, in the present day. The principle in brief is to mix intimately with the finely powdered mineral a certain proportion of a pure clay, or clay containing the smallest proportion of calcareous or silicious matter, which acts as binding and gives aggregation and solidity to the powder. The same system is employed for the formation of colored crayons, as well as for black lead-pencils. M. Conté prepared the clay on a gravitation principle. The clay coming from the pits was stirred for some time in a large quantity of water. It was then allowed to settle, and the supernatant milky liquid was drawn off by a siphon from near the clay surface into another vessel. This milky fluid was again allowed to settle and again the liquid drawn off, till a very fine clay only was deposited from the final drawing. This was then intimately mixed with a certain proportion of purified and calcined plumbago, on the quantity of clay depending the hardness of the pencil. M. Conté obtained admirable results with as much as three parts of clay to two of plumbago; a fine paste was thus produced. So far this system is used in the present time; the manufacture of the pen-

cils proper has been considerably modified. Before describing it we will, however, roughly sketch the old French method. The paste was now rubbed into grooves in a board, which was then covered by a flat board screwed firmly to the first, and the whole put aside to dry. This it did slowly, as only the ends of the sticks were exposed; but as they dried they shrunk, and allowed the air to reach the interior parts. When they were completely dry, the leads shook easily out of the grooves. They were then subjected to a very high heat, and afterward were ready for insertion in their wooden cases. By these two methods square leads only could be manufactured; but by employing round holes pierced in a metal block, through which the paste was pushed, instead of grooves in wood, M. Conté constructed round leads.

Not far from the Keswick railway station is situated the Greta Pencil Works of Messrs. Banks & Co. The river Greta passing under it supplies the building at once with a name and motive power. Two 12-ft. breast water-wheels, set at right angles to each other in the basement, drive the shafting by means of spur gearing. The establishment is not a large one—not more than about 50 hands finding employment there; among these are several women. It was established in 1832, and at that time was able to procure lead from the mines in the district. They are now, unfortunately, nearly exhausted, and plumbago has, as we have said, to be imported from Ceylon.

The first process, conducted in the lower part of the building, is to grind the material between French burrs; for fine leads this operation has to be continued from three to four weeks, the paste—water is employed—being returned over and over again, till it is judged to be of a sufficiently fine and even texture. The stones have to be frequently redressed, as the surfaces become highly polished.



LEAD-PENCIL CUTTERS.

The paste thus prepared is then dried in pans in an oven beside a coke fire for about 24 hours. It is then broken into small pieces and passed between steel rollers, which reduce it again to an even consistency. Afterward it is mixed with carefully prepared clay, on the proportion of the constituents depending the hardness of the finished lead. Thence the paste is passed into a small vertical cylinder, in the bottom of which is screwed a plug having pierced through it a hole of the diameter or section of the desired leads. A piston, actuated by a powerful multiplying gear and screw, is caused to descend, and presses the paste in a long string through the small orifice at the bottom of the cylinder. An operative breaks off lengths of about 2 ft. of this in his fingers, and arranges them in grooves in a horizontal board. If the finished leads are destined for use in pencil cases, the strings thus placed are cut off into the requisite lengths with a knife, on a board on which the different lengths are indicated by scratches. The leads are then allowed to dry naturally for some time, afterward they are roasted for a short period in the oven, and finally, packed on end in iron cases, are subjected to a very high temperature in a furnace. The leads for pencil cases are then put, a number at a time, into a "wobbling" tray, where they become highly polished by rubbing against each other. They have then only to be packed. The leads to be mounted in wood, omitting this polishing operation, pass to another department, where the operatives place them in grooves in slips of cedar wood. The wood being well glued first, then the leads, which are taken in small bundles between the thumb and fingers, and dipped first one end and then the other in boiling glue, the surplus of the mucilage being rubbed off with the other hand, are laid in place, and a similar grooved or flat slip of cedar—depending on the section of the lead, as will be explained later—is placed on the first. These slips are then clamped, a number at a time, in iron frames, and placed aside to dry.

We must now look back at the manufacture of the grooved slips. The cedar is reduced by circular saws from the balks in which it is received into small pieces of short length, and presenting a section sufficient to make 24 complete pencils of the ordinary size; six pencils to be cut out of the width. These blocks are again cut into thin slips by a circular saw. On one side of each slip along its whole length is cut by small circular saw a narrow groove at a certain distance from one edge; this groove serves as a guide through succeeding operations. The opposite side is then planed by a rotating cutter, and six grooves cut down its length by saws. If the case is for square leads, the grooves thus cut are of square section; if for round leads, of semicircular section. These are the slips that then pass to the gluing-up room, and for the square leads are covered by thinner slips, and for the round by a similar grooved piece.

When the glue has thoroughly set, the slips pass to the rounding machine. This machine is of very simple construction. The tool consists of two semicircular pieces of steel, in diameter perhaps 4 in., which are set eccentrically on a spindle rotating at a high speed. The accompanying sketch will give an idea of the tool. In the periphery of these pieces are formed grooves, presenting half the circumference of a pencil section. The operation is evident. The slips, fed one after another along a steel table under the tool, are first corrugated on one side; the operation being repeated on the other side, six circular sticks are produced at once. The succeeding operations are then cutting to length, sand-papering, and polishing, which are done by hand, four or five pencils being in treatment at a time, stamping the maker's name, etc. When this is to be done in gold, a woman rubs some bronze powder with a brush over the part to be stamped, a die actuated by a screw is then caused to descend on the pencil and impresses the letters; a row of small gas jets on each side of the machine slightly warms the die, which melts the varnish and causes the gold to adhere; the waste powder is rubbed off with a cloth.

On common pencils—joiners', etc.—where the name is not gilt, an apparatus is used which performs the operation instantaneously. It consists merely of two small wheels, one above the other in the same plane. The lower one is grooved to guide the pencil, and rotates. Around a portion of the periphery of the upper one are cut the letters to be stamped. On the spindle of this one is a small crank, which, in connection with a spring and cord, always pulls the disk back to its starting position. A spring also presses the upper wheel toward the lower, but not to touch it. The pencil end being inserted between the two, the pencil is at once snapped in, stamped, and ejected into a drawer placed to receive it.

Since the supply of Cumberland lead has failed it has become exceedingly difficult to make small establishments in this district pay, especially when they have to face not only an internal competition, but a foreign also, from such houses as Johann Faber's, of Nuremberg. This famous house was established in 1761. In 1885, we believe we are right in saying, there were engaged directly and indirectly in that business on the Continent 5,000 persons, turning out pencils at the rate of 250,000,000 annually, a quantity worth about $20,000,000.

It may be interesting to know that all the waste from the Keswick establishment is sent to Aberdeen, where it is employed in the manufacture of rough felt. This waste consists not only of outer shavings and sawdust, but of pieces of pencils which are rejected as being unsound on account of knots and defects in the wood. The felt is used principally for laying under carpets, the pleasant smell of the cedar rendering the felt popular.—*Engineer.*

PRACTICAL TRAINING OF STATE ENGINEERS IN WURTEMBERG.

THE practical training of engineers who intend to join the service of a State railway or other State concern has of late years been the object of serious consideration in Germany. It does not appear that universities and higher technical schools have been able to give anything like a training sufficiently practical for the requirements of the Public Works Departments, and this has led the Prussian State, and more recently that of Wurtemberg, to issue special prescriptions on this important matter.

The decisions arrived at refer both to civil and mechanical engineers. We will examine more especially the principal features of the prescriptions of the State of Wurtemberg relating to the training of mechanical engineers who wish to enter the service of the State.

These came in force on June 1, 1893, and were issued by the Minister of Foreign Affairs conjointly with the Ministers for Education and Finance.

Mechanical engineers intending to join the service of the State must have had three years' practical experience in an establishment belonging to the State. These three years comprise: 1. A year's practical work in a workshop previous to the passing of the first State examination in mathematical and physical sciences. 2. After the passing of this first State examination, two years' work in the supervision, accounts, stores and other departments connected with the State workshops; the greater part of this second period is spent in the study and designing of new machinery, and also in assisting the higher officials, or in the management of the works.

Those who wish to join the railway service must serve three months on a locomotive engine, and at the end of that time must be able to show that they can drive locomotives and trains.

The time spent in the supervision and accounts of a workshop must be six months. That spent in the designing of machinery and mechanical installations must be at least twelve months. The duration of the candidate's employment in an administration, or in the managing office of works, shall be at least three months. It will be understood that these various stages of the training have for their purpose to familiarize the candidate with practical work, and he is not to be employed in any responsible capacity unless circumstances absolutely justify it.

The work done in the shop has for its purpose to enable the candidate to acquire a practical knowledge of the branch he intends to select. He must acquire skill in the manipulation of the various tools, so as to be able to manufacture, himself, the engine parts, and get acquainted with the difficult points of the execution of the same.

Great stress is laid upon a sound knowledge of materials and their behavior when they are being worked upon, on the use of machine tools, the forms of engine parts, and the constructive development of the same. In this respect it is advisable that some time should be spent in the foundry and pattern shop.

The time spent in the workshop will enable the candidate to become acquainted with workmen and the conditions under which they have to work. It will also enable him to form a judgment about them and to learn how to treat them.

The time spent in the fitting shop must be six months at least; that in the foundry, two months. If the candidate has already some knowledge of pattern making, he need not spend more than a month in the foundry. A month or two must be spent in the smithy and in the lathe shops.

No remuneration is given to the candidate who is undergoing, in a State concern, the first year of his practical training. The first year over, the candidate is then entitled to sit for the first State examination. It will be noted that the time specified in the above looks somewhat too short; but it must be remembered that the thorough technical education already acquired in the higher schools, previous to entering the workshops, is sure to prove of valuable assistance to the candidate when he enters the workshops.

The length of these various stages must naturally depend upon the career which the candidate intends to follow. It is the intention of the legislature that the education of the future engineer should be of a more specialized nature than that previously obtained in the university or higher technical school. Those who intend to enter the carriage department need not go into the locomotive erecting shop, but devote most of their time to the practical study of that particular branch of rolling stock manufacture. This is all the more wise, as we know that a good locomotive engineer seldom makes a good carriage superintendent. We have already mentioned that those who have selected the career of locomotive engineer have to serve three months on an engine; the usual driver's examination is, however, in this case, limited to the driving of engines; for the candidate is supposed to know all about the working and construction of locomotives. A certificate stating that the candidate has acquired the necessary knowledge to drive an engine is duly delivered to him upon the completion of the period. During the six months' service spent in the managing and account department of a workshop, the candidate must be under the supervision of the workshop manager or director. The latter must impart to him all the necessary knowledge concerning the duties and responsibilities of the foreman of such a State workshop. The young engineer must be placed in a position to form an idea of the capacity of the workshop and its appliances, of the abilities of the operatives, and the quantity of work they can individually turn out. He will further have to take part in the inspection and testing of new or repaired engines, carriages, etc. The keeping of workshop accounts must also be explained to him, so that he may be able for a short time to undertake the duties, or assist the foreman of a small department; but the latter test should not occupy more than the last three months of the first stage of the second period of practical training. A certificate will then be delivered to the candidate, stating how the time has been spent, and in what works. It will also state what amount of practical knowledge has been obtained during that time.

Then comes a period of at least twelve months to be spent in the designing of engines and mechanical installations. The candidate will be entrusted more particularly with the preparation of working drawings for the department or branch he has selected.

Three months may be spent in the inspection and reception of the materials at the works, which are supplied by contractors or others to the State railway or other department, where the candidate is undergoing his two last years of practical training.

The greater portion of the twelve months must, however, be spent in the designing of machinery and mechanical installations. The three months spent in an administration have for their purpose to familiarize the young engineer with the working, attributions of the administration, and their management of the whole concern. Some time must be spent in the registering, secretary's, and revising offices. The drawing up of specifications, contracts, and agreements, must be rendered familiar to the candidate. The administration deliver a certificate as to the time spent in their offices.

During this second part of his practical training the young engineer receives a salary commensurate with the services he is able to render, and the regulations in force. But no salary is paid to him during the time spent in the administration, unless he is entrusted with special work requiring a special staff.

This completes the three years' practical training, and the candidate can sit for the final State examination, which, if successfully passed, qualifies him for the post of government engineer. The practical training may take place in private concerns; but certain formalities and prescriptions have to be fulfilled before the certificates delivered by such concerns entitle the candidate to pass the first and second State examinations.

It must not be thought that the granting of these certificates, and the successful passing of the final State examination are for the object of putting at the heads of various State departments comparatively inexperienced young men. The successful students are simply entitled to a responsible position in the State services which require a superior education and technical knowledge. They have to work their way up in the usual manner.—*Railway Herald.*

TRIAL OF SCHNEIDER'S NICKEL-STEEL ARMOR FOR RUSSIA.

An excellent statement of the conditions of a recent trial of nickel-steel armor, at Creusot, for the new Russian battleship *Tria Sviatitelia* (Three Saints) appeared in the *Times* of September 9, 1893. The plate measured 8 ft. × 8 ft. × 15.9 in. It, therefore, probably weighed nearly 18¼ tons. The conditions of acceptance were that it should receive four blows from Holtzer projectiles of chrome steel, weighing 317 lbs. each, fired from a 9.4-in. gun, with a striking velocity of 1,945 foot-seconds, without any portion of the plate being broken off, while in no case should the "*base* of the projectile" enter 7.8 in., measured from the face. The exact words used are "penetrate the target to a depth of as much as 7.8 in." The four rounds were delivered at the corners of an imaginary square of 4 ft. sides.

Round 1: Had a velocity of 2,001 foot-seconds; the shot's point entered 14.1 in., and the projectile rebounded "with the point smashed, and the shoulder somewhat set up." "The target showed three very fine cracks running from the wound."

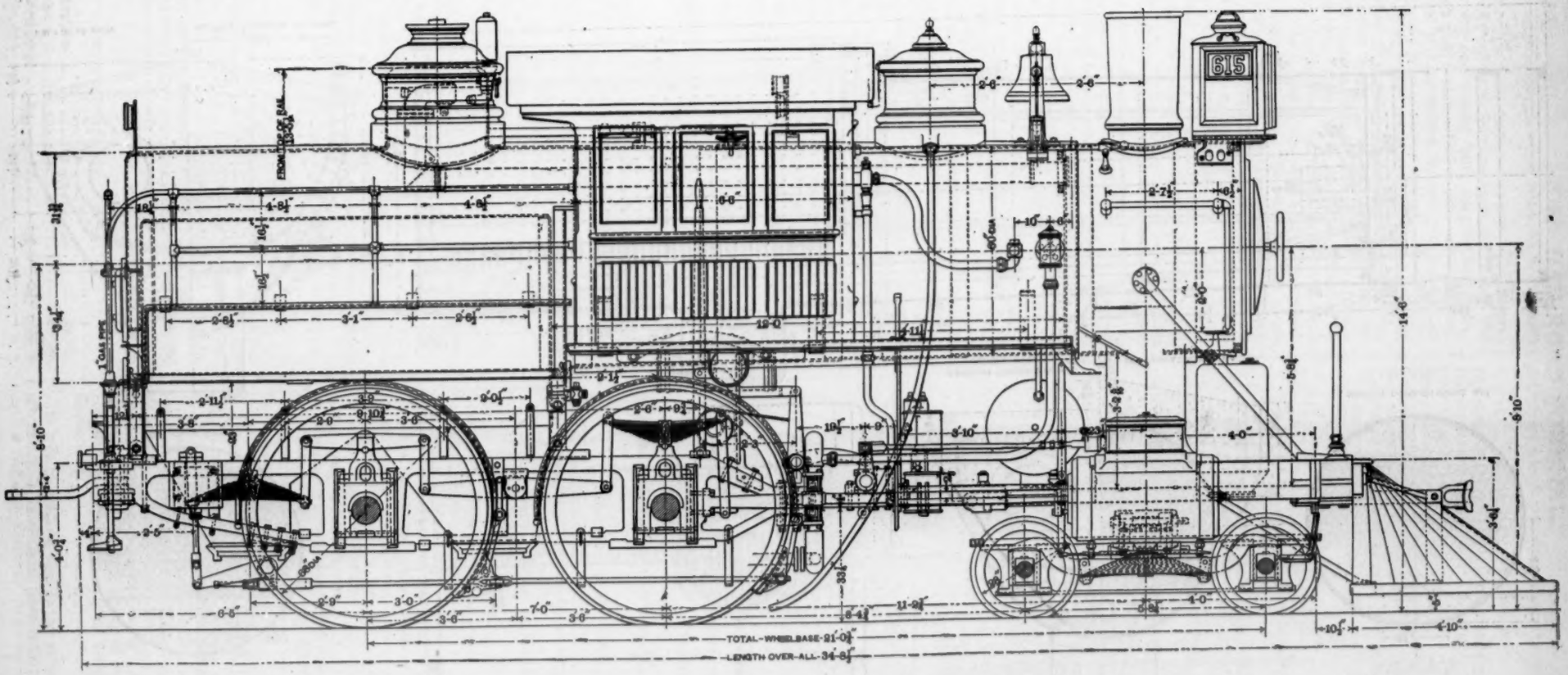
Round 2: Striking velocity, 1,948 foot-seconds; penetration of point, 10.9 in. The projectile rebounded, broken into numerous fragments. Three fine cracks, as before, were developed in the plate.

Round 3: Striking velocity, 1,923 foot-seconds; penetration of point, 14 in. The projectile rebounded with the head smashed, and the cylindrical part somewhat set up. A single fine crack was developed.

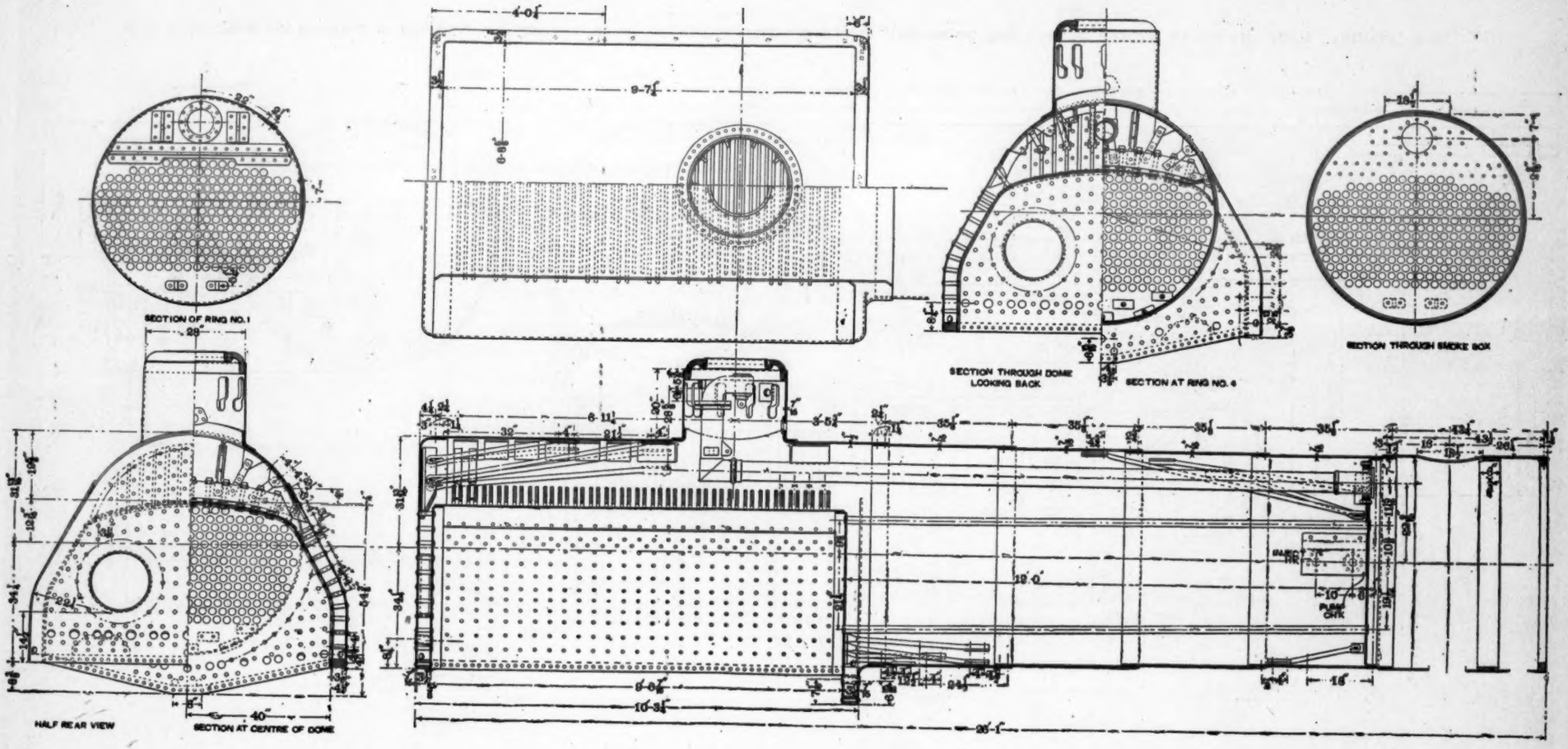
Round 4: Striking velocity, 1,962 foot-seconds; penetration of point, 9.9 in. The projectile rebounded, broken into numerous fragments. There were no fresh cracks, and the old ones were not increased.

At the back the bulges behind the points of impact varied from 1 in. to 1.7 in. high. Behind 1 and 2 were some fine cracks.

EXPRESS PASSENGER LOCOMOTIVE, BUILT BY THE LEHIGH VALLEY RAILROAD AT SOUTH EASTON, PA., JOHN I. KINSEY, M.M.



SIDE ELEVATION OF EXPRESS PASSENGER LOCOMOTIVE, BUILT AT THE SOUTH EASTON, PA., SHOPS OF THE LEHIGH VALLEY RAILROAD; JOHN I. KINSEY, M.M.


SECTION OF RING NO. 1
SECTION THROUGH DOME LOOKING BACK
SECTION AT RING NO. 4
SECTION THROUGH SMOKE BOX
HALF REAR VIEW
SECTION AT CENTRE OF DOME

BOILER FOR EXPRESS PASSENGER LOCOMOTIVE, BUILT BY THE LEHIGH VALLEY RAILROAD, AT SOUTH EASTON, PA.

We presume that this plate passed the test. To Messrs. Schneider is the credit due of having first applied nickel to the manufacture of armor, and having been long the sole manufacturers of through steel armor, which is now universally approved. Rare indeed is it for Messrs. Schneider to make a bad plate, and this plate is a very good one indeed. Messrs. Holtzer's projectiles have long been taken as the standard of highest excellence. These facts being so, it is interesting to compare the above trial with recent American and English results. In a trial which took place at Indian Head on July 11, 1893, a Bethlehem all steel nickel plate, 17 in. thick, was attacked by a 12-in. gun, firing forged steel Carpenter projectiles with varying velocities. The second round most nearly corresponded to the results now before us. The velocity was much lower—namely, 1,495 foot-seconds; but the theoretical penetration and the shock per ton were not so much less as to prevent comparison. On the English system the theoretical conditions are as follows: Schneider plate, third round, theoretical perforation through iron 17.36 in., the plate being 15.9 in. thick. Bethlehem plate, second round, theoretical perforation 19.18 in., the plate being 17 in. thick. The energies per ton of plate were respectively 483 and 425 foot-tons. The Schneider plate was therefore more severely tried as to fracture, and it may be noted that it exhibited a slight hair crack. The shot entered much more deeply in the Bethlehem, which, we think, was decidedly softer than Schneider's; undoubtedly both plates were excellent. To come to the projectiles, it can hardly escape observation that Holtzer's larger projectiles do not behave as well as those for his 6-in. gun. It may be well expecting a good deal to ask that 9.4-in. projectiles should rebound intact after impact at over 1,900 ft. velocity on steel, although the 6-in. projectiles will often do this. The Carpenter 12-in. projectiles rebounded apparently uninjured from the Bethlehem plate at, after striking, 1,838 ft. velocity. It may be urged that the Bethlehem plate was rather softer, and at this velocity it was overmatched. Still, making all allowance, the fact remains that, putting fracture aside, the Holtzer 8-in. projectiles at Indian Head, America, have been regularly and symmetrically setting up, and here, on this occasion, the 9.4-in. projectiles in two cases set up as well as breaking up. A projectile ought not to set up under any circumstances. Consequently, we think that Holtzer's larger projectiles cannot at present claim at all the high character that the 6-in. ones have maintained.—*The Engineer.*

EXPRESS PASSENGER ENGINE FOR LEHIGH VALLEY RAILROAD.

THE engine which we illustrate with a full-page, half-tone, and other engravings, is one which was designed and built some time since by Mr. John I. Kinsey, Master Mechanic of the Lehigh Valley Railroad at the South Easton shops. The general outline of the engine is one which has become very familiar to those who are in the habit of traveling over the anthracite roads of Eastern Pennsylvania, where the cab is located well to the front over the forward driving-wheels. In this position of the cab the engine rides remarkably easily, and is well adapted for fast running. In this engine, as in all of the other engines of the Lehigh Valley Road, anthracite coal is the fuel used. The engine was employed for some time by the Philadelphia & Reading Railroad, in hauling their fast express trains of the Royal Blue Line from Jersey City to Philadelphia, and gave remarkably good results, in that there was no difficulty with hot journals and insufficient generation of steam, the engine hauling the trains at various speeds ranging from 55 to 75 miles per hour between stations.

Below we give a list of the general dimensions of the engine:

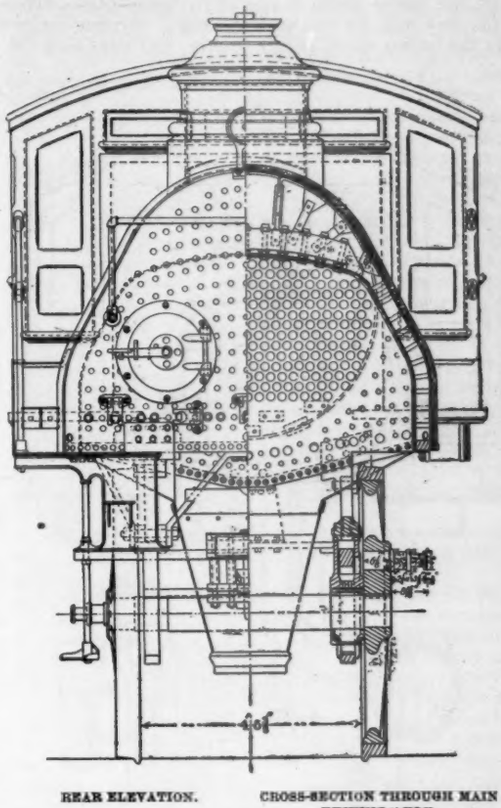
Gauge of road	4 ft. 8½ in.
Total weight of engine in working order	108,640 lbs.
Weight on driving wheels	77,616 lbs.
Weight on truck	31,024 lbs.
Total wheel-base	21 ft. ¾ in.
Distance between centers of driving-wheels	7 ft.
Length of main connecting-rod center to center	7 ft. 2 in.
Transverse distance from center to center of cylinders	6 ft. ¾ in.

CYLINDERS, VALVE, ETC.

Diameter of cylinders	19 in.
Stroke of piston	26 in.
Diameter of piston-rod	3½ in.

WHEELS, ETC.

Diameter of driving-wheels outside of tires	5 ft. 8 in.
Diameter of truck wheels	28 in.
Driving axle journal	7½ in. diam., 8 in. long.
Size of truck axle	4½ in. diam., 6½ in. long.
Size of main crank pin journal	4½ in. diam., 2½ in. long.
Size of coupling-rod journals	3½ in. diam., 3½ in. long.
Length of driver-springs from center to center of hangers	2 ft. 8 in.



REAR ELEVATION. CROSS-SECTION THROUGH MAIN DRIVING AXLE.

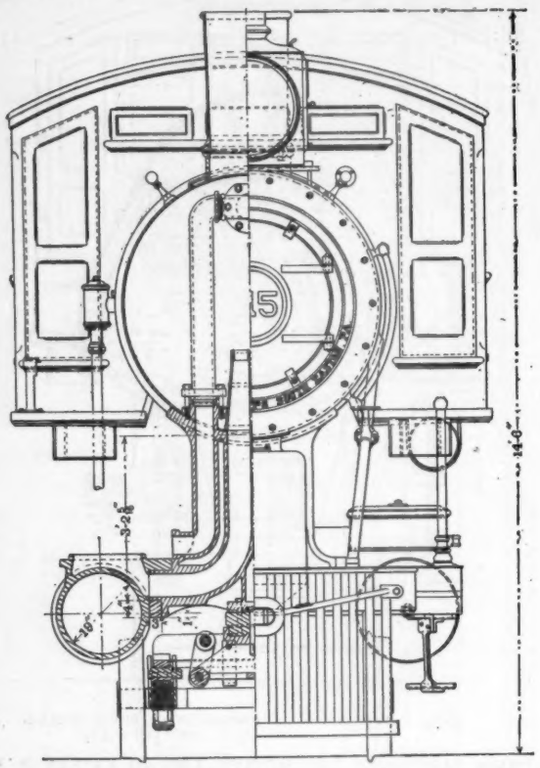
EXPRESS PASSENGER LOCOMOTIVE, LEHIGH VALLEY R. R.

BOILER.

General description	Straight top.
Inside diameter of smallest boiler ring	59½ in.
Material of barrel and boiler	Steel.
Thickness of plates in barrel of boiler	7/16 in.
Kind of horizontal seams	Lap, double riveted.
Kind of circumferential seams	Double riveted.
Material of tubes	Iron.
Number of tubes	263.
Diameter of tubes outside	2 in.
Distance from center to center of tubes	2½ in.
Length of tubes over tube plates	12 ft. 1 in.
Length of fire-box	9 ft. 6 7/16 in.
Width of fire-box	6 ft. 8 in.
Maximum depth of fire-box	54⅝ in.
Water space around fire-box	3½ in.
Thickness of plates inside of fire-box	5/16 in.
Thickness of plate back end of fire-box	½ in.
Thickness of crown plate	7/16 in.
Thickness of tube plates	½ in.
Method of staying crown sheet	Crown bars.
Inside diameter of dome	28 in.
Height of dome	20 in.
Kind of grate	Water bars and removable shaking bars.
Total heating surface	1,575.92 sq. ft.
Kind of exhaust nozzle	Double.
Diameter of exhaust nozzle	3⅝ in.
Smallest inside diameter of stack	17½ in.
Height from top of rails to top of stack	14 ft. 6 in.
Height top of rails to center of boiler	8 ft 10 in.
Grate area	63.61 sq. ft.

It will be noticed that in the arrangement of the tubes they are placed in horizontal lines rather than vertical, which is in

accordance with the older methods of tube arrangements, but which has been varied by other designers of late years, although it is the same as that which is used by Mr. Buchanan in the engine which we illustrate of English and American locomotives. The general appearance of the Wootten fire-box has been retained, and the staying of the sheets has been accomplished in the usual manner of running braces back to the shell. Stays are dropped down also from the side of the shell of the dome to the crown bars. The outside shell of the fire-box, which comes opposite the seams and opens at the upper end of the inside shell, is braced by angle plates riveted on, and the stay-bolt for the crown sheet is thrown out so that it enters the crown sheet nearly square, and runs into the outer



CROSS-SECTION THROUGH CYLINDERS. FRONT ELEVATION.

EXPRESS PASSENGER LOCOMOTIVE, LEHIGH VALLEY R. R.

sheet of the fire-box at a considerable angle. The spacing between the stay-plates at the outer shell at this point is 7⅞ in. This point is also stayed by a connection between the angle plate, which is riveted to the outside shell, and the crown bars, as shown in the cross-section of the boiler.

The mud ring is planed off on the corners so that there is a smooth lap for the outside sheet of the fire-box, and the trouble of making a tight joint at this point is to a great extent overcome, although it requires very careful fitting of the sheet that it and the planed-off portion should fit. The forward tube sheet is stayed above the tubes by angle plates riveted across, as shown in the end elevation, and braces running back to the shell, as already described. There are 10 water grates, each 9 ft. 9 in. long, and the crown bars are 4½ × 3½ in., varying in length from 50 to 62 in.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 483.)

Having thus designed and built his apparatus, the next point for M. *Maxim* to consider was how to get it up into the air, how to control it while sailing, and how to alight with it safely. To this he has evidently given much thought, and in an article published by him in the *Cosmopolitan Magazine* for June, 1892, he thus describes what course he would pursue if a sum of $100,000 were placed at his disposal, for constructing and experimenting a successful flying machine; which course seems to be so carefully planned that we may fairly assume that it is the one determined upon by M. *Maxim* for experiments with his own actual machine.

The machine should be run around the one mile track at all speeds, from 20 miles per hour to 100 miles per hour, and the power actually required should be carefully noted. These runs would enable us to ascertain how our pumps worked at high speed, and how much our screws pushed, and if we put a brake to the wheels we should find out the slip of the screws. We could also ascertain the efficiency of our condenser at various speeds, and the temperature of the water could be taken. In order to run on a railway track, the machine, of course, must be provided with wheels, and two sets of these would be necessary; one set should be of great weight, so as to hold the machine down when running on the track, and the other set should be light, for actual flying. Springs should be interposed between the axletrees and the machine, after the manner of railway carriages, and there should be attached above each wheel some sort of an index or indicator to show the exact load resting on each wheel. When all the parts of the machine had been made to operate smoothly and satisfactorily, the silk could be placed on the aeroplanes, and then our serious experiments might be said to commence.

We should first begin by running slowly—say at the rate of 20 miles per hour—and carefully note the lift on the indexes over each wheel. If we found that with a speed of 20 miles an hour, three fourths of the load was lifted off the forward axletree, and only one-fourth off the hind one, then we should change the center of weight further forward, so as to bring it as near as possible under the center of effort or lift. We should then make another trial, and if we found that the lift was equal both fore and aft, we should increase the speed very carefully, gradually observing the lift at the four corners of the machine, until the whole weight of the machine was supported by the aeroplane, and the whole weight of the wheels (about one ton) by the railway track. Then, when there was neither lift nor load on either wheel, we might consider that we had arrived at a stage in our experiments where we could turn our attention to the subject of steering.

A boat has to be steered in only one direction—namely, a horizontal direction, to the right or to the left. A locomotive torpedo or a flying machine must be steered in two directions—right or left, or up or down. We should experiment with the more difficult one at first—namely, the up and down or vertical direction. We should attach two long arms to our aeroplane in such a manner that they would project a considerable distance in the rear of the machine. To these arms we should pivot a very large and light silk-covered rudder and connect it with ropes, so that it could be turned up or down by a small windlass from the machine. We should then take a run on the track and see if the changing the angle of this rudder would increase or diminish the load on the forward or hind wheels. If we found that it would do this, but not sufficiently so, we should attach another rudder in exactly the same manner to the forward end of the machine. Suppose that, at a speed of 35 miles per hour, with both rudders set at the same angle as the aeroplane, we should find that the whole weight of the machine was carried by the aeroplane and the whole weight of the wheels (2,000 lbs.) by the track, we could then consider that the adjustment of our load was correct, and that the center of weight was directly under the center of effort for a speed of 35 miles an hour. We should then elevate the front edge of the forward rudder and depress the front edge of the rear rudder; this would cause the machine to lift on the forward axletree and the rear end of the machine to press on the hind axletree. If we found by changing the angle of the rudders that the load could be increased or diminished on either axletree to the extent of 15 per cent. of our whole load, we could consider that this phase of the problem was solved.

For horizontal steering we should try first the effect of the screws. There should be a three-way valve in the steam pipe connected with a lever, so that we should be able to partly close off the steam from the engine of one screw, and turn more steam on to the other. This would probably be all that would be found necessary; if not, we should try rudders.

To prevent the machine from swaying in the air, the aeroplane should so be constructed that no matter in which direction it tilted it would diminish the lifting power of the lifted part and increase the lifting power of the depressed part. This (diedral side wings) would be simple and automatic; moreover, the stability of the machine could be still further increased by having the center of gravity much below the center of lift.

Having all things in readiness, the heavy wheels should be removed and the light ones put on; and taking one man with

us to attend to the two horizontal rudders and to keep the machine on an even keel,* we should take our first fly, running the engines and doing the right and left steering ourselves. A day should be selected when there was a fresh breeze of about 10 miles per hour. We should first travel slowly around the circular railway until we came near that part of the track in which we should face the wind. The speed should then be increased until it attained a velocity of 38 or 40 miles an hour. This would lift the machine off the track and probably would slightly change the center of effort. This, however, would be quickly corrected by the man at the wheel. While the machine was still in the air careful experiments should be tried in regard to the action of the rudders; it should be ascertained to what degree they had to be tilted in order to produce the desired effect on the machine. The machine should also be run at a speed less than 35 miles per hour in order to allow it to approach the earth gradually; then the speed should be increased again to more than 35 miles an hour in order to rise, at the same time trying the effect of running one propeller faster than the other, to ascertain to what extent this would have to be done in order to cause the machine to turn to the right or to the left. If the machine should be constructed so that each particular foot of its surface carried a load of 1 lb. 2 oz., and if we should stop the engine dead and allow the machine to fall, it would approach the earth at a speed of 15 miles an hour, or one mile in four minutes. This evidently would cause a considerable shock, and unless there was a good deal of elasticity to the parts and a good deal of travel between the axletrees and the machine, the shock would probably be sufficient to distort or injure some part of the light structure. But it is not necessary to approach the earth directly. Professor *Langley* found in his experiments that when a horizontal plane was travelling rapidly through the air, it approached the earth as though it were "settling through jelly."

A large field as near our railway as possible should be selected for alighting, and having approached the field so as to be facing the wind, we should gradually descend by slowing up the engines, and finally alight while the machine was still advancing at the rate of 20 miles an hour. If the wind should be blowing at the rate of 10 miles an hour the machine would approach the earth very gradually indeed, so that all shock would be avoided. It would only require a few yards of comparatively smooth ground to run on after alighting, in order that there should be no disagreeable shock or danger.

The cost of these experiments would be from $50,000 to $100,000, and the time required would be two years.

It will be noted how complicated and delicate these various adjustments must necessarily be, and how many different parts must be made to do their work perfectly before it can be safe to venture into the air. The aeroplane surfaces must be prevented from altering their shapes at varying speeds, the rudders must be made to maintain the course automatically, the engine must be governed as to speed, the boiler and gas jet flames must be regulated by the consumption of steam, and the condenser must be efficient at all temperatures of the air, as well as at all speeds. Moreover, and most important, no part must break under varying strains, and the equipoise must be maintained.

These are formidable and yet indispensable requirements, well calculated to appall the boldest inventor; for while with an experimental model an accident is of little consequence and is easily repaired, with an actual flying machine an accident will probably prove disastrous, even if the inventor does not lose his life.

M. *Maxim*, therefore, has acted most wisely in taking plenty of time and in testing his apparatus in every way before venturing to leave the ground with it. Having completed it so that it was ready for the hazard of actual trial, he next experimented with it under conditions of comparative safety, and opened up the chapter of accidents.

The first difficulty he met with occurred through the breaking of some of the wire stays. These had been made of steel high in carbon in order to secure great tensile strength, and they proved brittle. From a private letter from M. *Maxim*, dated October 6th, 1892, the writer is permitted to give the following extract, which gives also a most interesting and hitherto unpublished description of the steam-engine and boiler, which constitute thus far the great achievement of M. *Maxim*:

The steam generator is constructed somewhat on the Thorneycroft principle, except that the tubes are much lighter and thinner and have a greater number of sinuosities in them. In the Thorneycroft boiler the distributing water tubes at the bottom are of considerable size and of great weight. In my engine they are only 2½ in. in diameter and 1¼ mm. in thickness. The downtake for the water is only 3 in. in diameter, and instead of having two, as with the Thorneycroft boiler, there is one, which branches off like the inverted letter Y. In the Thorneycroft boiler the difference in gravity of the water in the hot interior tubes and in the two external ones, which are not heated, is the only means of keeping up the circulation; but as all the passage-ways for water are very large, this is sufficient.

Suppose that in my system I am using steam at 300 lbs. pressure to the square inch; I have my water at a pressure of 335 lbs. to the square inch, and the water escapes through a species of automatic injector, and in falling 35 lbs. in pressure does a certain amount of work on the surrounding water. The cold water going in from the pump is therefore made to combine with the hot water in the downtake. This increases the gravity of the water and at the same time causes a very rapid forced circulation. No matter to what extent the fire may be forced, the water has to go through in any event. All the water that is coming in from the pump, as well as all of the water that it takes along with it from the top separating drum, from which the steam is taken, is forced through the hot tubes. The nozzle through which the incoming water escapes from the higher to the lower pressure is provided with a spring, which always keeps a difference in pressure of about 35 lbs.; whether the quantity of water pressing in is large or small, the difference is always the same. A very convenient apparatus is attached to the feed water pipe, by which it is possible to see at a glance exactly how many pounds of water per hour are entering the boiler. Directly over the boiler proper there is another series of very small copper tubes through which the water passes before entering the boiler proper, therefore products of combustion, after passing between the tubes of the boiler, are brought in contact with the incoming water before escaping. This so reduces the temperature of the escaping products of combustion that Brunswick black or linseed-oil are not burned off the smoke-stack.

For a fuel I employ naphtha of 72° Beaumé. This naphtha is pumped into a small vertical boiler heated with a part of its own contents.

The vapors from the boiler are led directly to an air injector, where they escape under a pressure of 35 lbs. to the square inch. The mixture of air and gas is then burned through rather more than 6,000 gas jets under the boiler. Steam might be also mixed if required. The distributing of the flame is very even, and it is possible to fill the whole fire-box with a purple flame. The regulating of the supply of naphtha is controlled by the weight of the gas generator; if the weight of the generator is too great, it operates upon a ratchet, which shortens the stroke of the pump; if it is too light, a spring raises the generator and its contents, when the ratchet operates in a contrary direction and increases the stroke of the pump. In this way the quantity of naphtha in the boiler is kept constant. The fire is regulated not only by the pressure in the boiler, but by a thermostatic regulator also. The feed-water pump is also regulated by changing the length of the stroke.

The engines are compound, and have a peculiar arrangement placed in a connection between the high and low-pressure cylinders in such a manner that if the pressure in the boiler rises above 300 lbs. to the square inch the steam is shunted past the high-pressure cylinder and enters the low-pressure cylinder, and it is arranged in such a manner that the pressure of steam falling from 300 lbs. to 100 lbs. does a certain amount of work on the exhaust steam that is passing through the high-pressure cylinder after the manner of an injector—that is to say, the escaping force of the steam reduces the back pressure on the high-pressure cylinder and increases the pressure on the low-pressure piston.

With two screws, each 17 ft. 10 in. in diameter, and with 300 lbs. pressure to the square inch, the machine has been made to pull on a dynamometer 1,960 lbs. If we multiply this pull by the number of turns per minute that the engine makes, and by the pitch of the screws, we find that the engines develop 300 horse power.

The complete weight of engines, boilers, pumps, generators, condensers, and the weight of water in the complete circulation, amounts to 8 lbs. to the horse power, and this of itself I consider quite an achievement

The spread of the wings of the machine is 107 ft., and the total length from the point of the forward rudder to the rear end of the after rudder is about 200 ft. Beneath the main aeroplane there is a considerable number of narrow planes superposed, which extend outward to nearly the full width of the machine. So far, trials have only commenced with the main aeroplane, which is 50 ft. wide and 45 ft. long in the direction of the length of the machine.

The whole machine is mounted on steel wheels 8-ft. gauge, and springs are interposed between the machine and the axletrees; both forward and back axletrees are attached to a dyna-

* M. *Maxim* has since added the gyrostat.

graph, which makes a diagram of the lift of the machine as it advances upon the track. The drum which holds the paper turns once round in 1,800 ft., and whatever the machine lifts either forward or back is recorded upon the paper drum. One of the drums is also provided with a pencil, which makes a diagram of the speed at which the machine is traveling.

I am very much hampered, however, for room; there is very little clear space between the trees, and to obtain adjoining premises without trees costs a prohibitive sum. What I should have is a circular or oval track, which would be a mile long. When the experiments are tried with a side wind blowing five miles an hour, a lift of one ton has been recorded on one side of the machine, while the other side would not lift over 100 lbs.

The whole machine, when loaded, will weigh about 7,000 lbs., so you will see if the machine will lift anything like as much, per pound of push, as I succeeded in lifting with my first apparatus, it will be sure to go.

However, I find that a great number of steel stays are necessary in order to hold the machine in shape, and while these do not weigh much, they appear to offer a considerable resistance to the passage of the machine through the air. If I were to build another machine I should aim more at getting less atmospheric resistance, because I can see now that everything else is assured except this single factor. If the machine does not go it will simply be because too much force is expended in driving the framework through the air.

Work has been greatly delayed, in the first place, because I was absent from England a great deal, and, in the second place, we have had several serious accidents. The high-class steel wires—plow rope—which are used for stays are not always reliable. On two occasions these wires have broken, and, becoming entangled in the wheels, have made a complete wreck of the wheels and everything about them. The last breakdown will take about a month to repair, and I shall put in a lower class of steel in all the stays that are near the wheels.

This damage was duly repaired, and the experiments were resumed early in 1893. In one of these, with a spread of somewhat more than half of the sustaining surface which the apparatus is designed to carry in full flight, M. *Maxim* succeeded in obtaining, at a speed of 25 miles per hour and with a thrust of the screws of 1,000 lbs., a lift over the front wheels of 2,300 lbs., and over the hind wheels of 1,900 lbs., as recorded by the dynagraphs. On a subsequent run, after making some alterations, he succeeded in obtaining, at a speed of 27 miles per hour and with a thrust of screws of only 700 lbs., a lift over the front wheels of 2,500 lbs., or quite all the weight resting on them, and of 2,800 lbs. over the hind wheels; thus showing a total lift of 7.57 lbs. per pound of thrust, as against 4.20 lbs. lifted per pound of thrust on the former occasion.

M. *Maxim* published the diagrams illustrating both these runs (and still another subsequently made) in the London *Engineer* for March 17, 1893, and gave a description in which he stated that the principal lift was obtained from the large aeroplane of 2,894 sq. ft. in area.

The run last above described was made on February 16, 1893, and on the same day two more runs were made until stopped by an accident.

First, an additional pair of wheels was attached under the front end of the machine, connected in such a manner that the small and lighter wheels could lift 3 in. from the track. Three men were also placed over the forward axletree, and a run was then made with 900 lbs. pull on the dynamometer. After the machine had run about 400 ft. the light wheels lifted clear of the track, and when the engines were stopped they came back to the track all right. The machine was then run again with 1,000 lbs. pull on the dynamometer, with the following result, described in a letter to the writer from M. *Maxim*, dated February 21, 1893.

I have had another accident with my apparatus.

My main aeroplane is 50 ft. wide and 47 ft. long in the direction in which the machine travels. I had another aeroplane directly in front of the engine, which was about 18 ft. long and 4 ft. wide. On the first runs which I had been making I found a great deal of atmospheric resistance which I could not account for except that it resulted from the bagging of the main aeroplane and the resistance offered by the numerous struts and wires which I used in my attempts to keep it approximately flat. With the engines running at a sufficient speed to give a push of 1,325 lbs., it was found that the lift on the aeroplane did not much exceed the push of the screws.

I then made a radical change in the manner of holding the plane flat, and tried my first experiments after this with a push of 800 lbs., when it was found that the lift was a great deal more than it was with the 1,325 lbs. in the previous experiments; in fact, the lift on the front pair of wheels was equal to the weight resting on these wheels, and the machine was only kept from leaving the track by the weight of three men whom I carried directly over the front axletree. This I regarded as dangerous. I then attached two very large cast-iron wheels in such a manner that the light wheels could lift some inches from the track before the heavy wheels were lifted at all, the weight of the heavy wheels and their axletree being about 1,400 lbs. Three men were also added to this load.

In making the run the gas was carefully turned on until the engines gave a push of 1,000 lbs. I had noticed that as the machine advanced and the engine ran faster, the boiler pressure was diminished. I therefore, upon starting, turned on a little more gas, so that the pressure, instead of falling, increased slightly during the run. When about 400 ft. had been covered, the two front wheels lifted off the track, leaving the heavy wheels still on the track; but just before stopping the heavy iron wheels also lifted from the track, and when the engines were stopped one of the wheels got into the soft earth, sinking down and tilting the machine over to one side. A gust of wind then tipped the machine on its side; but the breaking, which was confined almost entirely to the framework for holding the cloth, was caused by the impetuosity of a lot of men who tugged away at my ropes, and putting a strain downward instead of upward on the ropes, succeeded in completely destroying the framework.

The speed was 27 miles an hour, and the pressure of steam about 200 lbs. The lift recorded was nearly 6,000 lbs., as shown by the diagrams taken from the dynographs. The incline of the main aeroplane was, however, very steep, being about 1 in 9.

The lift was more than I expected. I did not think that a plane so very large, especially in the direction in which it was traveling, would be so efficient. I thought I should have to depend more on the narrow planes which extend beyond the main plane. This more than expected lift, however, may have been due to the wind, during the last end of the run, being contrary to the direction in which the machine was traveling.

I think that these experiments demonstrate that an aeroplane may be made to carry a considerable load.

It will take some time to repair the damage. None of the expensive machinery was damaged in the least. I shall take greater care in the future not to experiment when there is a liability to squalls, and shall have a fender, so that if the machine gets off the track it will not topple over.

It is understood that at the time this run was made about half of all the sails were in position—namely, 3,160 sq. ft The power which the engines developed was about half of their full power, so that it will be realized that there will be ample lifting power when free flight is attempted.

Since then the apparatus has been repaired, and in an article which has been extensively published in American newspapers, a correspondent, writing under date of London, September 12, 1893, gives an account of a ride which he took on the machine. After describing it and the house in which it is sheltered, he says:

I mounted the platform, made of light matched boards so thin that they seemed scarcely able to bear a man's weight. Prior to the start a rope running to a dynamometer and post was attached behind, to measure the forward impulse or push of the screws. . . . The action of the screws caused very little shaking through the whole machine, and this was a surprise to me, comparing the tremendous force with the delicate framework. Behind the ship, 10 ft. away, two men were shouting from the dynamometer and indicating the degree of push on a large board for the engineer to read. The index quickly marked in succession 400, 500, 600, 700, and finally 1,200 lbs. of push, and then the commander yelled, "Let go!" A rope was pulled, and then the machine shot forward like a railway locomotive, and with the big wheels whirling, the steam hissing, and the waste pipes puffing and gurgling, flew over the 1,800 ft. of track. It was stopped by a couple of ropes stretched across the track working on capstans fitted with reverse fans. The stoppage was quite gentle. The ship was then pushed back over the track by the men, it not being built, any more than a bird, to fly backward.

M. *Maxim* is quoted by the correspondent as saying, among other things, concerning his apparatus:

Propulsion and lifting are solved problems; the rest is a mere matter of time. . . . Haste in such a venture is the worst of policies. Weak points must be thoroughly sought for, and everything made completely safe before the public is invited to consider the air ship as a practical means of transit. I am looking for a location with more room for me to experiment in than I can find in England. I am cramped here for want of space.

Such is the present status (1893) of this bold and costly attempt to solve the problem of aviation with an aeroplane. M. *Maxim*, as he says himself, may not achieve final success; but he has, in the opinion of the writer, very greatly advanced the chances of eventual success. He has constructed, it may be said invented, a steam-engine with its adjuncts developing 300 horse power, and weighing only 8 lbs. to the horse power—an achievement hitherto unparalleled, and probably the most important problem to solve before man can hope to succeed in navigating the air at will.

There doubtless remain other problems to be worked out practically, notably that of effectually controlling a flying machine while in the air, both in the vertical and the horizontal direction; that of maintaining the equipoise under all circumstances of speed and angles of incidence, and also those of devising methods of starting up and of alighting safely anywhere; for in practical operation, even for war purposes, M. *Maxim's* machine cannot always be brought back to get a start upon its initial railway track.

There probably also remain some questions to be settled as to the best forms, extent and texture of the supporting surfaces; and it is not impossible that his experiments will eventually lead M. *Maxim* to a complete remodeling of his aeroplanes; but, as has been pointed out in discussing "screws to lift and propel," it is already within his power, by reason of his marvelously light steam-engine, to go up into the air with an aerial screw, and to perform therein various evolutions.

In any event, the name of M. *Maxim* must ever remain as that of one of the men who have hitherto done most to advance the solution of the problem of aviation.

(TO BE CONTINUED.)

CARE OF MARINE BOILERS.

By Robert Forsyth.

The boilers are the most expensive and perishable parts of the machinery of a steamship, often requiring to be replaced two or three times in the life of a vessel.

Deterioration and decay begin as soon as the boilers are in use, and are only partially prevented by care on the part of designers and engineers. At the present time the demand for large and fast steamships necessitates the use of boilers of great size and cost. The attention of builders and owners is, therefore, directed to keeping this portion of the machinery up to the highest point of utility for the longest period at the least expense.

Ten or 15 years ago eight years' work was considered a good average for a marine boiler, but the period of usefulness has been increased fully 50 per cent. within a few years. This gain is due in a measure to improved design and construction, but more, probably, to the more intelligent care bestowed upon boilers by modern engineers.

The first and simplest thing to guard against is

EXTERNAL CORROSION.

This arises from various causes—drips from leaky decks, leaky screw-stay bolts, leaky hand-hole plates, joints, stuffing-boxes, etc.—and from a cause so apparent that it would not be noted if it did not occur so often—namely, the neglect to water-proof portions of the boilers directly under hatch openings.

There is no good reason for the existence of any of these causes of corosion, yet they do exist and create a constant demand for the boiler maker's panacea—a "soft patch." The most serious point of external corrosion is the front of the ash-pan and the adjacent portion of the boiler head. The use of firing tools, wetting down of ashes and other causes, conspire to render corrosion at this point very rapid.

It may be counteracted in part by the persistent use on the ash-pan fronts of the waste oil or grease from the engine-room. A better method of protecting this part of the boiler, though seldom applied, is to fit soft patches or wearing plates of $\frac{5}{16}$ in. iron over the seams connecting furnace to front head, and extending over the lower part of the front head, to take in the front seam of the shell. This should be done when the boiler is new, and, although these wearing plates will last only a few years in active service, their renewal is simple and inexpensive, and therefore to be strongly recommended.

Four years' wear in hard service has been had from the wearing patches by keeping them smeared with the waste oils from the engine-room.

Wash of bilge water upon the shell is another cause of corrosion, and when the vessel is so designed that it is impossible to prevent the shell being wet by bilge water, it becomes necessary to keep the shells covered with some anti-corrosive material. The writer of this article has had a long practical experience with corroded boiler shells and the many preventives therefor, but has found nothing better or cheaper than coating the boiler shell below the furnace line with a mixture of engine-oil drippings and plumbago while the boiler is warm.

With ordinary intelligence bestowed upon the care of marine boilers, there is no reason why their period of usefulness should be shortened by external decay.

INTERNAL DECAY

is a much more serious matter. The chief causes of trouble inside boilers are: use of sea water, dirty fresh water, greasy water, cold feed water, imperfect circulation and contracted water spaces.

Using steam at a pressure of 160 lbs. per square inch evolves difficulties that did not exist at 75 lbs. per square inch. At the latter pressure a little supplementary feed from the salt water side of the condensers would give a coating of lime inside the boiler, prevent pitting, and the oil coming with the feed water would rapidly rise in the slightly brined water to the surface, and could be cared for by the scum valve; but while a $\frac{1}{16}$ in. scale on a back tube plate would not cause trouble at a working pressure of 75 lbs. per square inch, at 160 lbs. per square inch another condition of affairs exists. The tube plates having been thickened for increased temperature, the tube ends will leak from a very slight deposit on the tube plate.

The spray from a leaky tube end wetting the particles of ash, coal and dust carried by the draft forms a deposit on the other tube ends, and the furnace is rendered useless. If two furnaces are common to one chamber, both are disabled, much disagreeable labor is entailed, expanding the leaky tube, and this must be done repeatedly until there is an opportunity to thoroughly clean the boilers.

There is also danger, under forced combustion, of the tube ends leaking enough to cause a back draft from the furnace into the fire-room.

In the days of low-pressure boilers a thin scale was considered rather an advantage and protection to the inside of boilers, and it is difficult for engineers accustomed to that type of boilers to realize the changed condition with higher pressure.

Corrugated furnace crowns are seriously injured by even a thin scale, and it will be found that the corrugations near the middle of the grate, perhaps a little nearer the furnace front, suffer most. At this point the repeated opening of the furnace doors, and consequent change of temperature, causes the scale to crack, a new coating is formed, is again cracked, and so on repeatedly until, in some cases which have come under my observation, the scale after a 20 days' run had formed in leaves, attached to the corrugations like the leaves of a book to the binding, with the open edges of the leaves, about 1 in. over all, toward the front of the furnace, and the attached edges, about one-eighth of an inch thick, toward the back.

This shows that the evaporation is much greater at this part of the boiler; also that the corrugated furnace, if of good material, actually performs the duty for which it was designed—viz., expands and contracts without tearing the connecting seams of the tube sheets.

In the effort to prevent the formation of this scale it is customary to stop the supplementary salt-water feed and use instead distilled water from the evaporators. This frequently leads to serious trouble from the presence of grease in the feed water. Deposits of grease on the hotter parts, such as furnaces, lead to overheating and collapsing of furnace tubes; also to leakage at laps of back connections.

In parts of the boiler where less active generation of steam takes place pitting is sure to follow. The under sides of boiler tubes suffer most, also the sides of furnaces about the line of the grate bars; the rounded part of flange of back tube sheet, and sides and bottom of combustion chamber, below the approximate line of upper grate bars and near the water-line on shell and heads.

The pitting in these places is rapid and frequently unobserved in the earlier stages, the pitted parts being covered with a black moderately hard oxide, which, being removed by thorough washing and scraping, discloses the true condition of the metal attacked.

To prevent this overheating and pitting, from the presence of oil or grease, many remedies have been used with varying results. Filters of various kinds are among the most successful devices, sometimes applied on the suction side and some-

times on the delivery side of feed pumps. These filters are of various materials—sponges, blankets, coke, charcoal, gunny-sacks, horsehair, tan bark, hay, etc.—each being strenuously advocated by its particular selling agent, but the results depend more upon the care and judgment exercised by the engineer than upon the material of which the filter is made.

The filter which presents the greater surface in a given space, which can be readily replaced, and the material for which can be obtained at any port at small cost, will commend itself to engineers. But a filtering tank, filled with ideal material, will mechanically trap only a small percentage of grease if the filtering material is not frequently cleaned and renewed.

The designer of a filtering tank should bear in mind that the location, accessibility, and facility with which covers and interiors can be removed and replaced is of vital importance. Wass's air and grease extractor has been used with more or less success, depending upon the care and judgment of those using it. This filter is an enlarged chamber, on the discharge side of feed-pipe, with cross bars inside giving passage for the water, alternately over and under; a float operates an air and grease escape valve; by-pass valves and mud blow-off valves are also provided. Its operation is based upon the fact that the lessened velocity of the water in the enlarged chamber gives time for the grease to come to the surface and be automatically blown off by the accumulation of air operating the float valve. The mud, if any, will settle to the bottom and be blown off.

On one of the Puget Sound steamers, having a compound engine fitted with slide-valves, and using a working pressure of 120 lbs. per square inch, this filter was used, but the engineer, considering the amount of oil used on the valves excessive, stuffed the spaces between the division plates with hay, thereby greatly increasing the utility of the grease trap. The hay was renewed every day. Hay stuffed in gunny-sacks and blankets has been used with advantage in ordinary feed tanks, care being taken that all the feed water passes through the filtering material.

Efforts have been made to catch the grease in the main engine exhaust pipes, hoping thereby to keep the condenser as well as the boilers clean, but reports are conflicting as to the success of this device.

Feed heating arrangements assist materially in getting rid of grease. Gilmour's feed heater is a large chamber, fitted between feed-pump and boiler, necessarily a few feet above the working level of the boiler, into which is discharged, about half-way up, the feed water, filling the heating chamber about two-thirds full. A little below the feed inlet is an internal perforated steam-pipe with suitable regulating valve. The steam by direct contact heats the water almost to pressure point, and the sludge is precipitated to the bottom of the chamber.

A triple-expansion engine of about 1,500 I.H.P., fitted with this heater, has been under my observation for three years, and, with no other grease extractor, the boilers have been kept absolutely clean while on quite a hard service.

Cold feed water is injurious to boiler shells, furnaces, and furnace seams, and feed water should be heated to within a few degrees of the steam temperature before being discharged into the boiler, but this practice is not in general use. Weir's feed heater is one of the best in use, but is cumbersome, has many valves and pipes, requires two pumps, and the temperature is limited, being on the suction side of pump.

Direct injection of steam into the ordinary feed tank, and heating by coils in tank are open to the same objections. Discharging into the boiler with a series of inside pipes renders boiler cleaning more difficult. Heating the feed water by direct contact with steam, as by Gilmore's heater before mentioned, is so simple and satisfactory that it seems to meet all requirements.

When feeding with water from rivers or city supply, the direct contact of steam for heating, in a large chamber, where the velocity would be low, would precipitate most of the earthy matter.

Efforts have been made to neutralize the effects of oil in boilers by injecting sal soda, caustic soda, lime water, and potash with the feed water; but as the best cylinder oils are pure mineral oils and do not saponify, the results have not been satisfactory.

Zinc slabs in parts of the boiler showing decay seem to retard it somewhat, though a large quantity, sometimes amounting to tons, has been used without satisfactory results.

It will be found that boilers fed by an independent feed pump with feed water (from a surface condenser, *not leaking*), aided by an evaporator, filter, and heater, have very little tendency to pit below the line of the grate bars when an efficient system of mechanical circulation is maintained.

The use of the hydrokineter warms the water in lower parts of boilers when getting steam, but constant circulation is necessary, especially under banked fires, and the water should be pumped continually from lower front end of boiler to upper back end.

The value of this simple method is generally underestimated, and on many vessels the pumps are not fitted up for the purpose. Constant circulation by pumping prevents the lower shell seams being strained by unequal expansion, and reduces pitting below the grate line to a minimum. The benefit derived from constant circulation below the grate level seems apparent when we consider how little pitting takes place between the grate line and top of combustion chamber. In two-furnace boilers pitting below the grate line is greatly in excess of that in three-furnace boilers, a difference due to the better circulation maintained in the latter by the location of the middle furnace.

The tubes used in most vessels at present are greatly superior in make and quality to those in use 15 or 20 years ago, and when of No. 8 or No. 9 gauge will last six or eight years, giving little trouble. If only of standard thickness, however, which does not allow sufficient margin for scale spots and other surface imperfections, constant leakage will occur, whereas in the thicker tubes the result would be only an increased roughness of the surface.

If tubes are placed too close together cleaning is difficult, and tubes are liable to be burned at the back ends from an insufficient supply of water to tube plates. Tubes spaced to give 50 per cent. water surface to tube plates give practically no trouble, but if spaced to give only 40 per cent. are likely to make the water in boilers foam, and give endless trouble to keep back ends of tubes tight in the tube sheets.

When the tubes are overcrowded in the boiler various methods are resorted to, such as ferrules and cements, to prevent leaking of tube ends. But all such devices are merely temporizing with the difficulty, which exists primarily in the defective design.

The use of steam at 160 lbs. per square inch has led to the abolition of that danger trap, the superheater, one of the most formidable foes of the old-time boiler-room, fitted as they were with one, two, three, or four vertical flues hooped with angle irons, and usually too narrowly spaced to permit inspection. Corrosion and pitting could go on *ad libitum*, and usually the first intimation of trouble would be the bulging of the flues. The interior could not be examined without cutting the shell.

Now that boilers are made a little larger, giving more water surface for steam to escape, the necessity for a superheater no longer exists, nor do the difficulties which it was intended to obviate.

On the flame side of the furnace decay takes place at the point of contact with the bridge wall, and as the deterioration covers a large surface, it is apt to escape detection until the plate is quite thin. By placing thin sheet iron between the bricks and the furnace plate each time the bridge wall is rebuilt the decay may be retarded. Around the manhole joint, in the interior surface of the plate, pitting occurs partly from the presence of suphur in the rubber gaskets, and partly from repeated buckling opening the surface of the plates.

The wear of boilers depends much upon the character of the service in which the vessel is employed. Tug boats, bay steamers and coasters, in the order mentioned, seem to suffer more than ocean steamers.

Irregular application of heat, lying under banked fires for long periods, and irregularity of washing out boilers, will account in a great degree for this difference.

The care of a marine boiler when not steaming is of great importance. If empty, it should be quite dry; if it contain water, it should be *quite full* and have no leaks. Sudden stopping of engines, without an independent air-pump to care for the steam, is a constant source of injury to boilers, as it is difficult to check the pressure without notice. There is, of course, no difficulty with independent air-pumps to care for the steam.

The use of forced draft has added to the difficulty of caring for boilers, especially with the closed fire-room system as the admission of cold air when the furnace doors are opened is the worst possible treatment for back connections and tubes. The induced draft system is little, if any better, either with the fan or the jet in the smoke-stack. The alternate high and low temperature from the intense heat of the fires, and the inrush of cold air when the fires are replenished, demands a very elastic duty from materials and conditions that are the reverse.

Forced draft with the closed ash-pit system affords better control of the steam-making power, and depends less upon the trim of ventilators or direction of the wind, especially in the tropics, where fire-room duty is always severe. It is also free

from the great objection of admitting a rush of cold air when fires are replenished The main objection to its use is the increased length of fire-room required with the ordinary type of marine boiler, but its use in moderation is extending, and all the appliances to supply it are of the most permanent and durable character.

This system does away with the difficulties arising from handling coal from different bunkers and discharging ashes, which are encountered with a closed fire-room, and the longest voyages may be made with a regularity of steaming impossible with a closed fire-room or natural draft.

The foregoing remarks apply particularly to the ordinary type of marine boiler, but of late years the demand for high pressure and less weight per horse power has brought into use various forms of water-tube boilers, the care of which is equally important. All that has been said as to the necessity of supplying pure water is more imperative with the water-tube boiler than with the older type. Being more flexible, the water-tube boiler suffers less from forced draft with closed fire-room, but, being more susceptible to change of temperature and having a small storage of water, will suffer greater loss, from a steam-making standpoint, than if used with closed ash-pit system. The rapidity with which steam can be raised from cold water, and the reduced weight per horse power, ensures a favorable consideration for this type of boiler; but the actual durability is yet to be demonstrated.

The life of grates, bridge walls, and furnace fronts depends almost entirely upon the coal used. With Pacific coast, Australian, Japanese, Chilean, and the lower grades of English and Scotch coals, the furnace fittings wear well, the linings of the fronts and doors suffering most when the fire is too near the front. With good grades of Welsh or Pennsylvania coal the wear is much greater, especially if dampers are used suddenly to prevent blowing off steam when it is necessary to stop the engine quickly.

The most durable grate bars are the thinnest, and wrought iron is preferable, as these can easily be straightened or pieced out aboard ship, when cast-iron ones might not be obtainable.

Breechings, front connections and doors require constant attention when lignite or flaming coal is used, and if not kept in repair add to the consumption of coal and interfere with the draft. With patching and repairing, front connections, doors, and uptakes will usually last as long as the boilers; not so with the smoke-stack. In active service, ten years is a long life, but this, again, depends on the quality of coal used. If flaming coal is used the smoke-stack has a very short life, not more than three years with some of the lignites.

The outside of the smoke-stack is protected by paint, but as yet we know of nothing that would afford protection to the interior. A few vessels are provided with hoods to protect the smoke stack when laid up, but these are seldom used when the vessel is in commission.

It is the custom of late years to cover the greater part of boiler shells with non-conducting material, and to cover this again with some water-proof material, either sheet lead, galvanized sheet iron, or painted canvas. If either of these water-proof coverings are permitted to leak, the non-conducting material, being porous, absorbs the moisture and causes corrosion. There are numerous non-conducting coverings which, when properly put on and kept water-tight (which is seldom), will last as long as the boiler.

Bottom and surface blow-off valves, feed-check valves, and gauge cocks require constant attention. The scour from blow-off is particularly bad on the seats of the blow-off valves, and, if neglected and permitted to leak, entails serious trouble with blow-off pipes. These valves should be ground in or faced up frequently. In using the blow-off at sea the gradual and simultaneous closing of outboard and inboard valves will greatly reduce wear on pipes. In these pipes the dynamic effect of the sudden change from cold water to hot pressure, and reverse, is very great and will sometimes split the heaviest pipes.

The gauge cocks must of necessity be blown through to keep them free, and if the composition contains zinc they last but a short time. I have renewed them after three months' wear, when the keys looked more like sponge than metal.

Boilers well designed, constructed of the best materials, and equipped with the most approved fittings, may be a source of constant annoyance and expense for lack of intelligent care in the matter of raising steam and blowing off the water. If boilers and pipes are slowly and equably warmed before pressure is raised, a most fruitful source of leakage is avoided.

When, at the end of a voyage, steam pressure is blown off, dampers and doors should be closed and the water left in the boilers to cool gradually (a couple of days if practicable) before being pumped out. Attention to these details will be well repaid by the absence of leaks, which are inevitable when boilers are blown out with steam pressure.

The length of time a boiler of the present type may be used varies so much under different conditions that it is difficult to arrive at a satisfactory average.

I may instance two sets of boilers, of the same type and on similar service, one set of which was renewed after eleven years' service.

These boilers were steam-tight at a working pressure of 60 lbs., and from the furnace side were apparently as good as ever. Yet the back connection sheets were found to have been reduced in thickness by decay from $\frac{7}{16}$ in. to barely $\frac{1}{16}$ in. in thickness. Where decayed the combustion chamber had only 1½ in. to 2 in. space between that and the shell.

The other set of boilers, having 3½ in. to 4½ in. water space around combustion chamber, was found to have worn very little at these points, and was continued in service three years longer.

Another marked instance has come under my observation, where the machinery of two vessels on same service show marked difference in wear. The boilers in one vessel required renewal after seven years' service, while in the other they have now been running 16 years, and appear to be good for many years more. In the latter case the same chief engineer has had charge of the machinery from the beginning of service.

In one instance, of boilers 13 years old, I had the back tube plate (after the boilers were cut apart) knocked around with sledge hammers until it was doubled over upon itself, without showing any sign of cracking; and I think something similar will be found with the majority of old boiler plates *if the material has been good* when the boilers were new.

As boilers have been built and equipped, their life has been about 12 years, with pressure from 60 lbs. to 90 lbs. per square inch, and while they could be repaired and run longer at lower pressures, it would not be a commercial success to do so.

Among the many old boilers I have repaired or removed, I have found that, as a rule, comparatively little decay has taken place above the bridge walls, and the shells were pretty good except the lower parts, but the furnace, ash-pan, lower back connection, and lower stays made me wonder how it was possible for the parts to hang together and stand a pressure test.

With the superior quality of steel available for the construction of boilers at the present time, drilled holes, improved workmanship, and the use of corrugated or other elastic furnaces, the life of boilers may be much longer than formerly. Sufficient water spaces around the connections, evenly distributed bracing, tube space not crowded, the use of hot, filtered feed water, and mechanical circulation of water in boilers, will, I think, with the renewal of tubes and furnaces, prolong the life of marine boilers to nearly 20 years, under the supervision of intelligent engineers, notwithstanding the fact that the pressure has been advanced to 170 lbs. per square inch.

"Eternal vigilance is the price of safety" in the case of steam boilers, and the engineer who despises small things will be continually beset with small troubles, which, in the aggregate, will greatly reduce the period of service of boilers and engines.—*Journal of American Society of Naval Engineers.*

"SCHNEBELITE"—A NEW EXPLOSIVE.

EXPERIMENTS were made recently in England with yet another "smokeless explosive," the invention of a Frenchman, M. l'Abbé Schnebelin, and called, after him, "Schnebelite gunpowder." The basis of this powder is chlorate of potash, a substance which has hitherto been used only for the manufacture of detonating compounds, on account of the facility with which it can be detonated by percussion or friction when mixed with some inflammable material such as sulphur or black sulphide of antimony. In fact, the mixture of chlorate of potash and sulphur was used in the earlier patterns of percussion caps for muskets, and the mixture with black oxide of antimony is still employed in the ordinary friction tubes with which the charge in muzzle-loading guns is usually fired. The violent detonating property of these mixtures is due to the fact that the chlorate parts with its oxygen at a much lower temperature than the nitrate of potash—the oxidizing agent in ordinary gunpowder—and also to the peculiarity that, when decomposed by heat into oxygen and potassium chloride, it is attended with evolution of heat, while in most cases of chemical decomposition heat is absorbed.

In "Schnebelite" the chlorate of potash is mixed with pure cellulose, or woody fiber, such as is used for the manufacture of guncotton or Schulze powder. The advantages claimed for it by the inventor are numerous, the principal being as follows:

1. Facility and cheapness of manufacture.
2. Almost smokeless.
3. Very slight recoil.
4. No fouling or oxidation of the rifle.
5. Unless confined will only burn gradually, and not explode.
6. Imperishable, retaining its properties even after being wet, and involving no danger when heated.
7. Non-explosive by concussion or friction, and requiring 540° F. to ignite it.

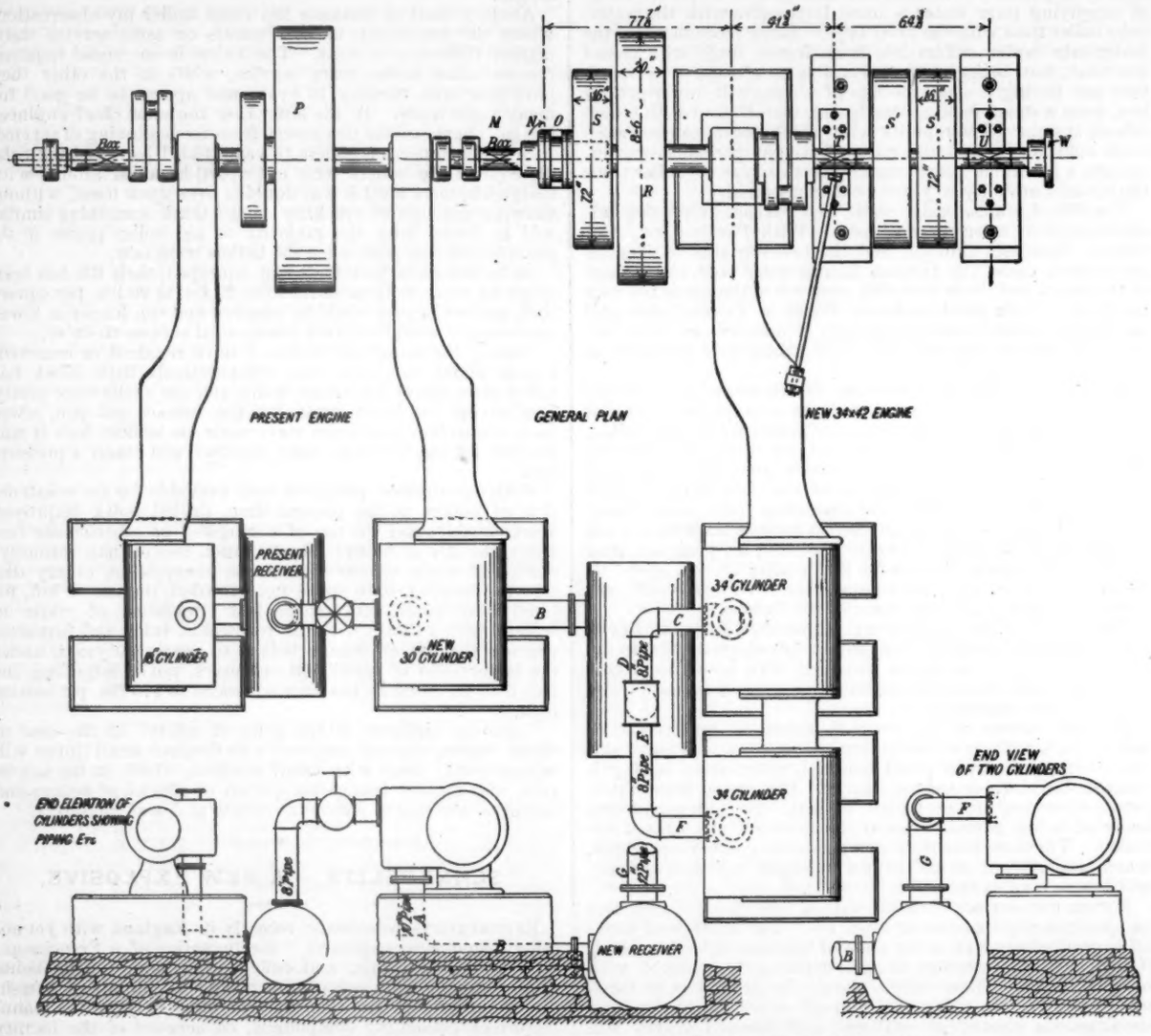
The appliances at the disposal of the Abbé, who conducted the experiments personally, were not sufficient to allow of any exhaustive tests of this explosive as to its value as a propelling agent as compared with the powders now in use. But these trials were so far interesting that they proved conclusively that the inventor had succeeded in producing a gunpowder with chlorate of potash as its base, which, notwithstanding the generally accepted opinion of the violence of compounds in which this substance is used, appears to be completely under control. When fired from the new magazine rifle the recoil was very small, while the penetration of the bullet through both wood and steel plates was such as to show that the velocity obtained was satisfactory, though there was unfortunately no means of measuring it. The charge employed was about 20 per cent. greater than that of service powder, and it claimed that the pressure on the barrel of the rifle is very small. The smoke was light and very quickly disappeared, while the fouling of the bore was very slight. The claim to non-heating of the barrel was not, however, proved, as after the firing of 10 rounds with rapidity the barrel in front of the chamber was decidedly heated, though it could be handled without discomfort.

The trial in a sporting gun showed that this powder is about equal in hard-hitting to the ordinary E. C. powder.

To exhibit the safety of this new explosive a quantity coarsely granulated was ground into fine powder in an ordinary coffee-mill; another sample was struck by a heavy hammer on an iron anvil, and when thus reduced to powder was ignited by a match and burnt quietly away.

A charge of small shot was fired into a box containing about a quarter of a pound without producing any ignition or explosion, and the same was done to four small cylinders (for use in blasting), the broken fragments and scattered powder being in each case collected and burned in the open without any explosion.

Though only preliminary and inconclusive, these experiments indicate that this explosive has several qualities which would render it suitable for use as a propelling and a destructive agent, but much more exhaustive and detailed experiments are necessary before any decided opinion can be arrived at. The safety and facility of manufacture, and its cheapness, are in its favor; some of this powder was made in the morning after the visitors arrived on the ground, taking only a few minutes, and this same powder, after being dried for a couple of hours, was fired from the shot gun in the afternoon, with excellent results as to penetration.—*London Times.*



TRIPLE-EXPANSION ENGINE, BUILT BY THE FITCHBURG STEAM-ENGINE COMPANY.

NOVEL TRIPLE-EXPANSION ENGINE.

Some time ago the Fitchburg Steam-Engine Company, of Fitchburg, Mass., built a compound condensing engine with cylinders 18 and 34 in. in diameter by 42 in. stroke, for Spring

Forge, Pa. The engine was coupled directly to the main shaft, the engine shaft ending at the coupler marked *N* in our illustration, from which point the main line shaft extended 200 ft. or 300 ft. The shaft also extended in the opposite direction a short distance, a portion of the power being taken at that end, but the main part through the coupling *N*. The fly-wheel *P* is very small, because it is necessary to permit passage by it, but it is also very heavy, as its rim is nearly a foot thick.

The 500 H.P. developed by these engines proving insufficient, the plan was suggested by the Fitchburg Steam-Engine Company of removing the line shaft from the half coupler *N* to the coupler *W*, and inserting an entirely new engine with the necessary shaft, leaving the driving pulleys as shown at *S S S*, and putting in a shaft of the proper size for the engine toward the coupler *N* of 8 in. in diameter from the engine to the coupling *W*, with two very heavy boxes at *T* and *U*. The fly-wheel *R* is also very heavy in the rim, because it was necessarily made small. The driving pulley *S* is fitted in halves to the hub of the coupling to save room, and there is inserted a coupling, *O*, in halves diametrically, so that this can be taken out and the shaft moved endways to get at the boxes or to remove the crank-pins when desired. The reason for crowding the engines into this small space is that there was no more room available, and the company's works were so located that no enlargement was possible.

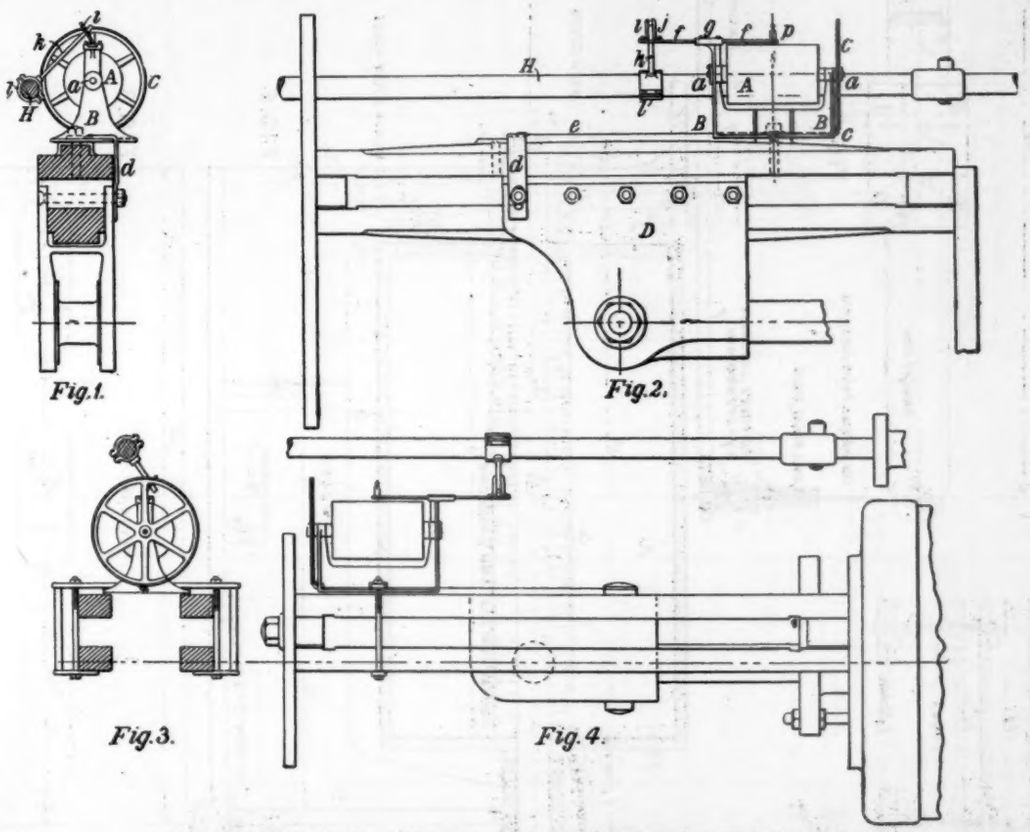
The old 34-in. cylinder of the original compound engine was removed from the low-pressure side and one of 30 in. in diameter substituted for it. Two 34 in. tandem cylinders were placed upon the new engine and the exhaust from the 30-in. cylinder taken into a steam-jacketed receiver, and from this by distinct pipes to the two 34-in. cylinders, the exhaust being taken from them to a Bulkley condenser of sufficient size for both cylinders. By the addition of these two cylinders and with a steam pressure of 125 lbs., the engine readily develops 700 H.P., and while the conditions are peculiar so far as connecting directly into a line shaft are concerned, everything seems to work with entire satisfaction, and there is no trouble with belts or gears.

The engine makes 90 revolutions per minute, giving a piston speed of 630 ft. The general arrangements are very clearly shown upon the engraving. A heavy bolt was led off from the engine bed to the bed-box, as shown, so as to strengthen the resistance of that box against the strains of the steam.

VALVE-MOTION INDICATOR USED ON THE BALTIMORE & OHIO RAILROAD.

THE movement and action of the slide-valves of a locomotive is probably more difficult to understand clearly, and is of more importance to the satisfactory working of the machine, than any other of its purely mechanical functions. Any device, therefore, which will represent this action with absolute correctness and clearness, and will show exactly the *actual* movement of the valves of locomotives, must be a great help in the diagnosis of their defects and disorders. A device which does this with absolute precision is illustrated by our engravings, for the drawings of which we are indebted to its designer, Mr. F. J. Cole, Mechanical Engineer of the Baltimore & Ohio Railroad, who says in a letter to the editor of this paper:

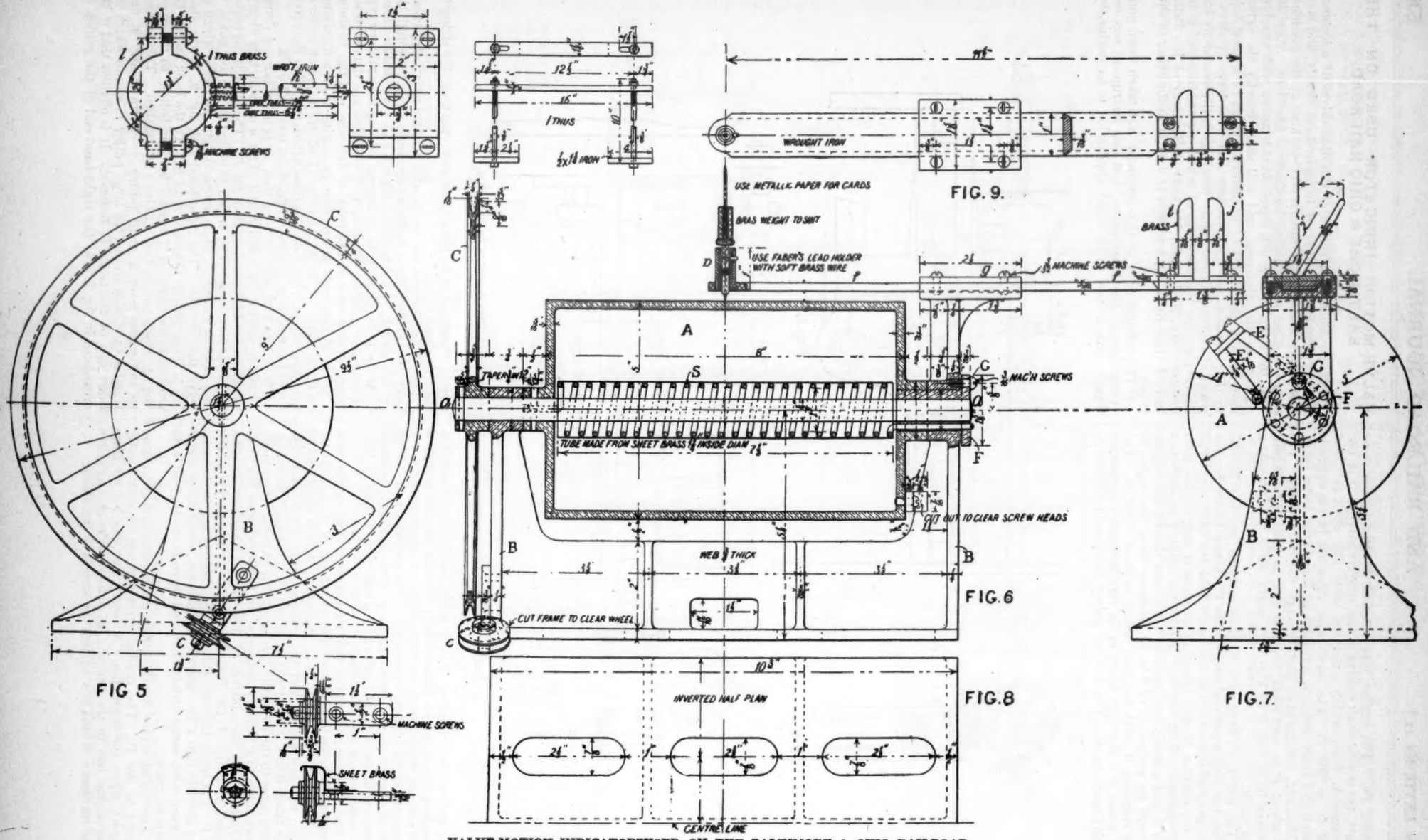
"The primary idea of this indicator was taken from your 'Catechism of the Locomotive,' but this instrument was designed with a view to its rapid application to an engine, by merely clamping it to the guides and attaching the string to the cross-head key."



VALVE-MOTION INDICATOR USED ON THE BALTIMORE & OHIO RAILROAD.

Figs. 1 and 2 show the instrument applied to a Laird cross-head and guides, fig. 1 being a transverse section through the guides, and fig. 2 a side view. Figs. 3 and 4 are similar views, showing its application to an engine having the ordinary type of four-bar guides. Figs. 5, 6, 7, 8 and 9 are detail views, engraved to a scale of one third of full size, and fig. 10 shows a series of diagrams taken from an engine with a maximum travel of valve of 4⅜ in., and fig. 11 shows a similar series of diagrams taken from the same class of engine, with the eccentrics changed so as to give a maximum travel of 5¼ in.

From fig. 2 it will be seen that *A* is a cylindrical drum, which is carried on a horizontal shaft *a a*, which is clearly shown in the horizontal section, fig. 6. The shaft is supported by a cast iron stand *B B*, which is bolted to the top guide, in this case by means of bolts screwed into the holes which receive the oil cups. The right-hand end, fig. 2, of the shaft has a large pulley *C* attached to it. To the back end of the cross-head an angle or ⌐ shaped bar *d* is bolted, to the upper end of which one end of a twine *e* is attached. This extends to and passes over a small pulley *c*—shown clearly in figs. 5 and 6—and then around the large pulley *C*, and to which the other end of the twine is fastened. It is obvious that if the cross-head in fig. 2 is at the right-hand end of the guides, its



VALVE MOTION INDICATOR USED ON THE BALTIMORE & OHIO RAILROAD.

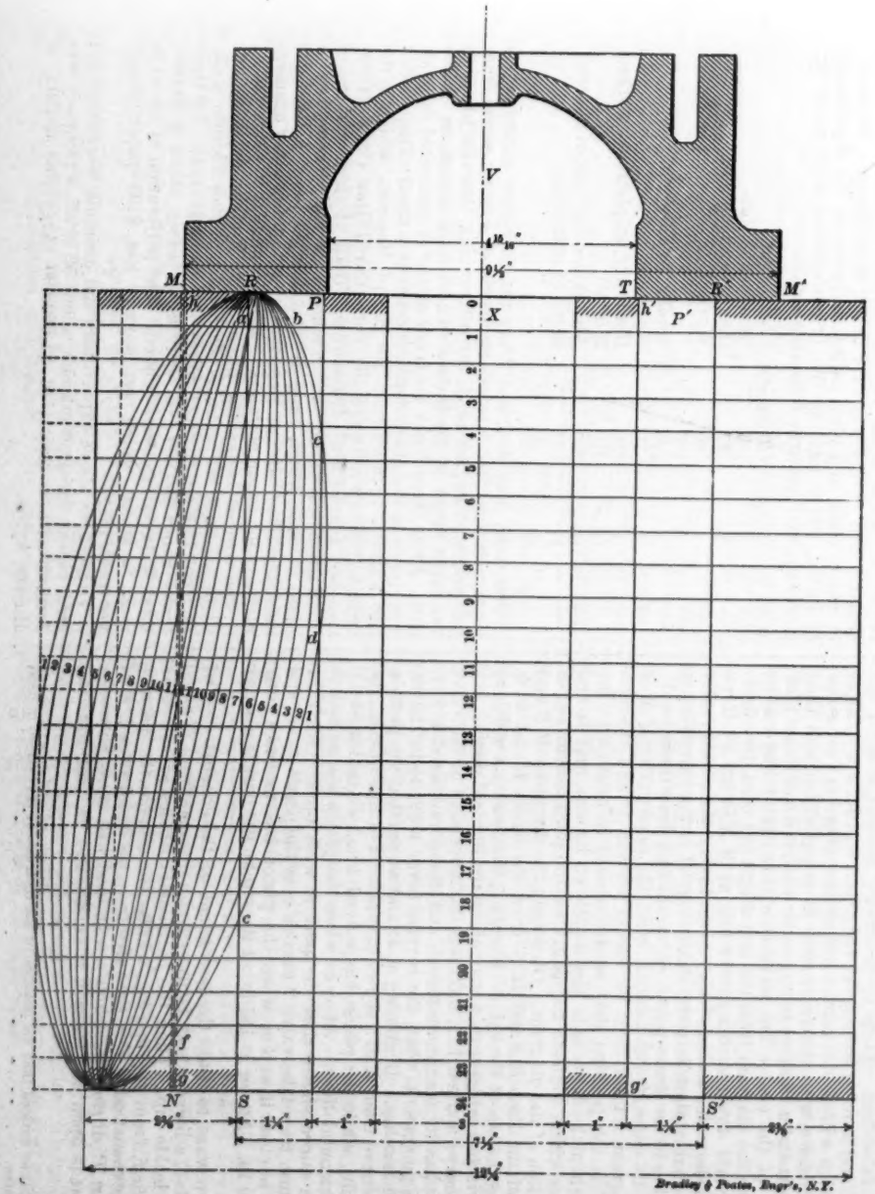


Fig. 10.

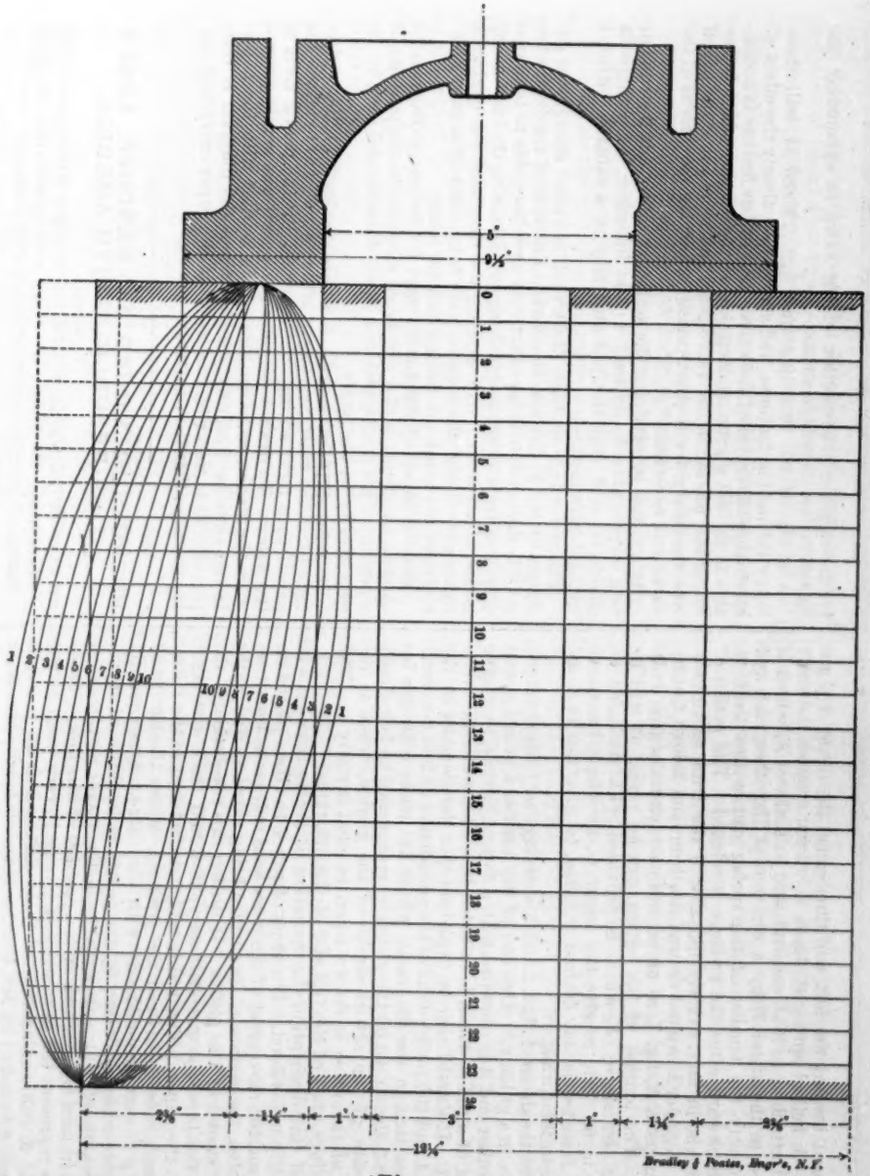


Fig. 11.

SLIDE-VALVE DIAGRAMS TAKEN ON THE BALTIMORE & OHIO RAILROAD.—SCALE ½.

movement toward the left will thus cause the drum *A* to revolve. A helical spring *S*, fig. 6, is wound around the shaft *a a* and attached to it at one end, and to a sleeve *F*, which is fastened to the stand *B* by a screw *G* at the other end, and consequently the tension of the spring causes the drum to move backward after the twine *e* is relaxed. The action of the drum is, in fact, exactly like that of the drum of an indicator. A paper is wound around the drum and is held fast by the clamps *E E*, fig. 7, as on an ordinary steam-engine indicator. The tension of the spring can be varied at will by turning the sleeve *F*, which is provided with six holes, as shown in fig. 7, to receive the screw *G*, by which the sleeve can be fastened in any desired position, to give the required tension to the spring.

Above the drum *A*, figs. 2 and 6, a sliding bar *f f* is arranged to move in a guide *g*.* One end of this bar has a pencil *p*, and at the other end it is provided with a forked jaw, *i j*, to receive the end of a rod *k*, which is fastened by a clamp *l* to the valve-stem *H*. It should also be explained that the diameter of the drum *A* and the pulley *C* have the proportion of 5 to 9 to each other, so that in the diagrams which are made with this instrument, the stroke of the piston is represented as being only five-ninths of the actual stroke of the engine, whereas the travel of the valve is drawn equal to what it really is. The engravings are ¼ of the full size of the diagrams.

From this description the operation of the instrument will be readily understood. If a sheet of paper has been placed on the drum, the movement of the cross-head will cause the drum to revolve, the motion of its surface being equal to five-ninths of the stroke of the piston. If during this revolution of the drum the pencil *p* was stationary, it would trace a straight line on the paper. The rod *k*, which is fastened to the valve-stem and is held between the jaws *i j*, causes the bar *f* and pencil *p* to move coincidently with the valve. Consequently the figure which is drawn by the pencil is an elliptical curve, the breadth of which depends upon the travel of the valve, which in turn is governed by the position of the link. These curves represent the movement of any and every point of the valve. A full explanation of these curves will be found in the book referred to by Mr. Cole, so that it is hardly necessary to repeat it here. The curves may represent the movement of any point of the valve, but in order to be able to assign them to some particular part, we must have a center line to lay off the steam-ports from. To draw such a center line the engine may be moved so as to bring the valve in its central position on the valve-face. Then by detaching the rod *k* from the jaws *i j*, and moving the engine, the pencil will draw a straight line, which will be the center line of the diagram; or a line may be drawn with the valve-stem in any position, and then if by means of a tram, or in any other way, we can know how far out of the center the valve is, a true center line can be drawn on the diagram from the line which has been described. Having laid down such a center line as *M N* in fig. 10, if we want to show the action of the valve during the admission of steam—that is, show how the steam-edge *M* of the valve moves in relation to the steam-port—we would first draw the valve *V*, so that its edge *M* will coincide with the center line *M N* of the diagram. Then draw the steam-ports *P P'* and exhaust-port *X* in the position they would occupy in relation to the valve when the latter is in the middle of its seat, and extend the lines which indicate the edges of the ports downward to the bottom of the diagram. Obviously the distances *M R* and *M' R'* of the lines *R S* and *R' S'* from the edges *M* and *M'* is equal to the lap of the valve. Knowing this, and the width of the ports and bridges, they may all be readily laid down.

The curve marked 1, 1, indicates the movement of the valve when it has its maximum travel, and those numbered 2, 3, 4, etc., its movement when the reverse lever latch is in the respective notches. Beginning at *R*, and we see that the portion of the curve from *R* to *b* shows that the valve has opened the port ¼ in., while the piston has moved 1 in., as indicated by the horizontal lines. At *c*, or when the piston has moved 4½ in., the curve shows that the port is wide open. With the maximum travel the valve "throws over the port" $\frac{1}{16}$ in., and begins to close it at *d* or when the piston has moved a little over 10 in. At *e* or at 18¾ in. of the stroke the port is entirely closed.

If we want to study the movement of the exhaust edge of the valve, a line *h g* may be drawn at a distance from *M* equal to the inside lap. Then the horizontal distance of the curve *R b c d e f*, from the line *h g*, will be the same as the distance of the exhaust edge *T* of the valve from the inside edge *h' g'* of the port *P'* during the whole stroke, and will show how wide the port is open and when it is closed, and, in fact, indicates to the eye the exact action of the valve in exhausting the steam during the whole stroke.

A study of the two diagrams, figs. 10 and 11, will show many interesting features, and shows very clearly the effect of increasing the travel of the valve. A curious feature is noticeable in the flat places on each side of the curves, which is due to the lost motion in the valve-gear, and shows that the pencil was stationary for a short period, while the movement of the valve was reversed.

As a means of studying the action of valves this instrument is a very valuable adjunct to the indicator, or perhaps it should be said that the indicator may be a valuable adjunct to this instrument.

The one which we have illustrated, as stated above, was designed by Mr. F. C. Cole, Mechanical Engineer of the Baltimore & Ohio Railroad, who says that "we have been able to take two diagrams from an engine applying and detaching the instrument inside of an hour." In making the diagrams the engine is run continuously, the reverse lever being moved at each revolution as the crank-pin turned over its center.

Metallic paper of the quality used for indicator diagrams is used on the drum, and a soft brass wire serves the purpose of a pencil. This is attached to a kind of sleeve, and rests by its own gravity on the paper.

In some experience with a similar instrument the writer found that the most convenient arrangement was to attach the pencil to a light spring which would lift the pencil clear of the paper. To draw a diagram the pencil was gently pressed with the finger, so as to bring it in contact with the paper. It can thus be instantly released when the diagram is completed, and is never in contact with the paper excepting during the time that the diagram is drawn.

* It will be noticed that the position of the instrument is reversed in these two figures.

PETROLEUM MINING AT MENDOZA, ARGENTINE REPUBLIC, SOUTH AMERICA.

RESULTS OF 12 WELLS WHICH HAVE BEEN WORKED—PETROLEUM USED IN PLACE OF COAL AND EFFECTING A GREAT ECONOMY TO THE RAILWAY COMPANIES USING IT.

ONE of the many mineral products found in the Argentine Republic during the last three years has been crude petroleum, which was first believed to be existing in the province of Jujuy, but after some $100,000 had been expended without favorable results to the mining company, it was resolved to abandon that province and try in the adjoining one, Mendoza, in which State, at a place called Cacheuta, in the department of Lujan, where recently the 12 perforations were made for petroleum and gave the following results:

Well No.	1,	depth	110	meters.	Abandoned.
" "	2	"	103	"	Gave asphaltum.
" "	3	"	67	"	Good petroleum.
" "	4	"	90	"	Worked.
" "	5	"	103	"	"
" "	6	"	200	"	Spoiled by carelessness.
" "	7	"	70	"	No result.
" "	8	"	210	"	Hot water, sulphurous; worked.
" "	9	"	210	"	Worked.
" "	10	"	220	"	Abandoned for want of material.
" "	11	"	104	"	Signs of petroleum.
" "	12	"	30	"	" " "

The wells Nos. 4, 5, and 9 are the only ones giving petroleum, and these are worked by means of a crank-wheel from the principal engine shed, the oil running through pipes to two large tanks in the hollow, which have a capacity of 200 c.m. From these tanks the crude matter is conducted through 5-in. pipes to the chief depôt, located at a small village called San Vicente, 1½ miles from the city of Mendoza, which is the terminus of two railways, the Ferro Carril Gran Oeste Argentino and Ferro-Carril Trasandino. Both of these companies use a great deal of the native mineral for their locomotives in place of coal, which costs at least $12 per ton. A large gas company established at Mendoza is one among other concerns utilizing the crude petroleum, which is similar to black tar.

The cost of laying the piping from well to depôt (where there is a tank which holds 3000 c.m.), at San Vicente, a distance of 42 kilometers (24 miles), was about $124,000; for three tanks, about $80.000; for working expenses, about $420,000; total, $574,000 (national dollars). The perforation of the wells must be added, which cost, more or less, $105 (paper money) per meter (39⅜ in.).

To meet the above expenditure and maintain workshops and erect houses for the workmen, about 50 in all, a company was formed with a capital of $1,000,000 (Argentine dollars) at Buenos Ayres.

As it is so styled, La Compañia Mendocina de Petróleo has an extent of about four square leagues (12 miles) of ground, and the works are at the foot of a spur of the Cordilleras de los Andes.

The price at which the petroleum is sold varies according to the money market, but the average rate is $12 in gold the cubic meter (cubic yard), or 55 cents per gallon. Since the first borings commenced at Cacheuta (Mendoza) over 2,000 tons of fluid have been produced, which seemingly made a difference in the figures of imported petroleum for the year 1891, when only 2,300,000 galls. of that oil was received in the Argentine Republic against 3,100,000 in 1888.

To illustrate the advantage of using petroleum as an engine fuel instead of coal, I will give an extract from one of my engine mileage and storage sheets (Argentine Great Western Railway Company) of two locomotives for one month. Engine No. 50 (running on coal and wood) traversed 683 miles, consumed 21,709 lbs. of coal, 1,550 c. ft. wood; oil and tallow, 117 lbs.; hauled 10.383 vehicles. Engine No. 51 (with petroleum fuel and little coal) ran 1,312 miles, consumed 8,593 lbs. of coal and 35,155 lbs. of petroleum, hauling 24,484 vehicles, consuming 174 lbs. of oil and tallow. In the following table is a *résumé* of averages upon each of the before-mentioned engines:

	No.	Average of		
		Coal per Mile.	Oil and Tallow per 100 Miles.	Vehicles Hauled per Mile.
		Lbs.	*Lbs.*	
Engine.....	50	31.78	17.13	15.20
"	51	{ 6.82 / 26.79 Pet. }	13.26	18.66

The above figures show very clearly the saving there is in having petroleum as fuel, and it will be worth the while of North American engineers and locomotive superintendents to turn their attention a little more to liquid fuel, which has been used with success on a few railroad lines in South America.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in September, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN SEPTEMBER.

Portsmouth, O., September 5.—A west-bound mixed train on the Cincinnati, Portsmouth & Virginia Railroad ran through an open switch at Reardon at three o'clock this morning, colliding with a work train on the siding. Fireman Robert Little, of the mixed train, was instantly killed, and the engineer, George Glasgow, was fatally injured.

Aurora, Ind., September 5.—A Big Four freight train came into collision with an express at Batesville this morning. The accident took place at the bottom of a steep grade six miles north of Aurora. The engineers of the two trains, Samuel Sheehy and John Winslow, were injured, both being cut about the hands and face.

Grass Valley, Cal., September 6.—A narrow-gauge train on the Nevada County Narrow-Gauge Railway, hauling Sells & Renfrew's circus, was wrecked a mile and a half from here this morning shortly after midnight. Daniel Coghlan, the engineer, had his hip sprained, and Joseph Duffy, the fireman, was bruised about the body. The train was proceeding slowly around a curve when the horses in a box car overbalanced it, derailing the train. The escape of the engineer and fireman was considered miraculous, as their engine was thrown upside down and they were thrown out.

Radnor, Pa., September 6.—A coal train ran into a freight train at this point this afternoon, completely wrecking several cars and injuring the engineer and fireman of the freight train. Track No. 1 at this point was being held by a passenger train which was delayed, owing to a hot box. The operator, not knowing that the passenger train had come to a standstill, had given the signal for the freight to go on to track No. 1. Before the freight had cleared track No. 2 the coal train came along and crushed into the rear of the freight. The engineer, Jacob Givens, was bruised about the hands and legs, while the fireman, Elias Lightly, was internally injured.

White Plains, N. Y., September 6.—Herbert Blake, a fireman on the shop train engine of the Harlem Road, fell from his engine as a train was coming out of the Fourth Avenue Tunnel at Ninety-ninth Street this evening. He rolled across the opposite track. The Saratoga express train narrowly missed cutting him in two. His skull and right leg below the knee were fractured, and his chances of recovery are very slight.

Colehour, Ind., September 7.—A collision occurred just south of this point on the Chicago, Pittsburgh & Fort Wayne Railway at 9.30 this morning, between a milk train and an east-bound passenger train on the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad. The accident occurred on the Y running from the main line just south of Colehour to East Hammond. The fireman of the Pittsburgh, Cincinnati, Chicago & St. Louis train was internally injured.

Valparaiso, Ind., September 7.—The Valparaiso accommodation train on the Fort Wayne Railroad, which left here at 7.30, was run into by a fast passenger train on the Pan Handle Railway about 30 miles west of this city. The engineer and several passengers of the latter train are reported killed and 20 injured.

Dutton, Ont., September 8.—The fast express on the Michigan Central, for Chicago, ran into the rear of a freight train near this point this morning. The fireman on the express train was slightly hurt.

Easton, Pa., September 8.—Jacob Spencer, an engineer of a local freight on the Lehigh & Susquehanna Railroad, was struck by a Lehigh Valley shifting engine at Phillipsburg this morning, but escaped with a lame leg and bruises about the body.

Rockford, Ill., September 9.—Andrew J. Fair, engineer on the Chicago, Burlington & Quincy Railway, was killed near Hinckley this morning. His engine left the track near the switch and ran into a box car on the side track.

Mumford, N. Y., September 9.—The Lehigh Valley Railroad flyer, running over the Buffalo, Rochester & Pittsburgh Railroad, ran into a local freight train at 8 o'clock this morning. The engineer, Jesse Randall, was badly injured.

Woonsocket, R. I., September 9.—An engine hauling the Northern Express of the New York, New Haven & Hartford Railroad, broke a connecting-rod on the left-hand side of the engine just this side of Northbridge this evening. The adjacent parts of the machinery were demolished and the cab battered. The fireman, William Reall, jumped and sustained a compound fracture of the right leg.

Findlay, O., September 10.—At 6.45 o'clock this morning two freight trains on the Nickel Plate Road crashed into each other four miles west of McComb and two miles east of Leipsic Junction. The locomotives were wrecked and 40 cars piled in a mass of débris. John Davidson, engineer of the east-bound freight, was instantly killed, and his fireman, J. N. Umpher, with Engineer Charles Merritt, of the west-bound train, received fatal injuries.

Chestertown, Md., September 10.—When near Black's Station this morning, an eccentric-rod under an engine on the Baltimore & Delaware Bay Railroad broke, ramming a hole in the fire-box. George Byrnes, the fireman, to avoid being scalded, leaped from the train, which was running at the rate of 25 miles an hour, but was caught and dragged about 50 ft. Several ribs were broken and severe injuries received about the head, while his body was badly bruised, and it is scarcely possible he will recover. Engineer James Boggs leaped from the train and was badly bruised.

Chicago, Ill., September 10.—A World's Fair train on the Illinois Central Railroad ran into a switch engine standing on the track at Twelfth Street at about midnight to-night. The fireman of the Fair train and the engineer and fireman of the switch engine jumped and received no injuries. Oscar Griglass, engineer of the passenger train, stuck to his post and sustained a severe fracture of his right ankle.

LOCOMOTIVE RETURNS FOR THE MONTH OF JULY, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	822	....	.....	.... ..	. . ..	1,973,198	3,339	....	....	....	....	....	78.09	....	...	4.34	6.54	0.23	1.53	6.64	0.16	19.44	...	..	1.58
Canadian Pacific	614	....	561,959	716,338	607,332	1,885,629	3,071	....	....	....	....	...	62.79	....	...	3.26	10.03	0.31	....	5.65	1.28	20.55	....	....	3.17
Chic., Burlington & Quincy	541	....	.....	.....	.....	1,579,530	2,919	5.73	18.75	....	....	....	75.27	..	.	4.63	5.07	0.23	0.16	6.67	0.05	16.81	....	....	1.35
Chic., Milwaukee & St. Paul	857	...	.....	.....	.....	2,414,107	2,817	....	....	....	...	....	63.21	....	....	4.13	6.27	0.29	...	6.93	...	17.62	....	....	2.15
Chic., Rock Island & Pacific	....	....	617,922	947,905	382,848	1,948,675	. ..	....	..	54.96	72.19	36.04	59.51	....	....	2.50	5.46	0.26	2.50	5.92	0.41	14.55	.. .	...	1.96
Chicago & Northwestern	888	....	802,464	1,250,485	719,701	2,772,650	3,122	....	...	....	...	....	78.20	....	....	3.34	7.24	0.36	....	6.39	0.81	18.14	...	. ..	1.83
Cincinnati Southern	....	....	.....	.....	.....	.....	...	....	....	.	....	....	....	....	....	...	....	....	...	...	...	....	....	....	....
Cumberland & Penn.*	....	23	6,305	30,555	.....	36,860	1,602	....	....	....	....	....	91.57	....	...	6.82	4.25	0.40	....	...	2.11	13.58	....	....	....
Delaware, Lackawanna & W. Main L.	211	196	.....	.....	.....	655,099	3,342	....	..	..	...	....	86.28	....	....	3.16	6.85	0.49	.	5.93	....	16.43	...	...	...
Morris & Essex Division	....	....	.....	....	.....	....	....	....	....	...	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....
Hannibal & St. Joseph	74	74	.. ..	.. ...	.....	240,935	3,492	6.00	16.62	....	....	....	76.02	12.69	5.96	3.67	5.18	0.12	0.03	6.86	0.29	16.15	....	....	1.39
Kansas City, F. S. & Memphis	145	...	101,320	180,387	94,318	377,225	2,601	....	....	....	....	....	59.47	....	....	3 30	5.52	0.35	0.43	7.50	...	17.10	....	....	1 85
Kan. City, Mem. & Birm	42	38	37,299	39,635	15,340	92,274	2,428	....	....	.	....	..	54.60	....	....	5.27	3.05	0.25	0.36	7.01	....	15 94	....	....	1.06
Kan. City, St. Jo. & Council Bluffs	37	37	.....	.....	... ..	136,939	3,701	5.29	20.57	....	....	. ..	61.03	12.00	4.84	3.46	5.57	0.15	0.18	6.16	0.04	15.56	....	....	1.90
Lake Shore & Mich. Southern	599	....	511,421	705,614	469,026	1,686,061	2,814	....	....	56.72	81.55	35.01	60.50	....	....	3.12	4.62	0.18	....	6.87	0.20	14.99	....	....	1.52
Louisville & Nashville	....	....	.....	.... ..	.....	... .	...	..	...	....	..	....		....	....	..	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	271	744,016	.....	60,587	804,603	2,971	....	....	..	....	....	38.83	....	....	2.00	7.80	0.20	....	9.00	...	19.00	....	....	4.05
Mexican Central	148	115	... .	.....	.....	359,694	3,127	...	...	....	....	....	69.42	....	....	5.94	13.38	0.51	0.21	4.85	0.84	25.73	...	....	4.28
Mil., L. S. & Western	112	....	99,724	135,664	65,633	301,021	2,687	....	..	....	...	....	73.62	....	....	3.70	8.85	0.16	....	6.13	0.94	19.78	....	....	2.45
Minn., St. Paul & Sault Ste. Marie	....	....	74,064	168,695	9,428	336,387	....	4.63	20.38	....	....	....	61.57	....	....	3.11	10.88	0.26	...	6.69	....	20.94	...	...	3.53
Missouri Pacific	338	....	.....	.....	.....	1,059,564	3,531	4.42	16.15	...	....	...	....	....	....	4.65	5.42	0.33	1.17	6.25	1.43	19.25	3.87	1.45	1.38
Mobile & Ohio	107	82	76,044	141,382	55,331	272,757	3,325	. ..	19.60	...	....	....	57.98	....	....	2.10	4.10	0.22	0.65	5.80	0.97	13.84	....	....	1.43
N. O. and Northeastern	....	....	.....	.... .	.....	.....	....	....	....	....	....	....	..	....	...	...	...	....	....	....	....	....	....	....	...
N. Y., Lake Erie & Western	...	619	489,906	848,150	280,899	1,618,955	2,615	5.10	22.60	87.90	125.50	73.45	95.61	17.30	5.60	4.93	6.60	0.38	2.30	7.23	1.13	23.57	....	....	1.28
N. Y., Pennsylvania & Ohio	....	255	167,074	403,910	148,035	719,019	2,835	6.10	18.40	69.50	115.50	83.75	89.58	11.40	6.30	4.10	5.48	0.30	1.84	6.81	0.99	19.52	....	. ..	1.15
Norfolk & Western, Gen. East. Div.†	....	....	133,391	268,794	53,738	455,923	2,714	5.00	21.20	45.14	116.27	....		9.20	5.50	5.90	3.90	0.40	....	....	....	10.20	....	....	....
General Western Division†	....	....	122,461	281,246	42,486	446,193	...	5.30	16.70	65.00	117.00	....	107.00	12.17	7.58	8.03	4.29	0.36	....	....	....	13.68	...	....	....
Ohio and Mississippi	113	...	143,411	135,818	88,733	367,962	3,256	....	....	....	....	....	71.12	....	....	3.24	2.79	0.25	1.27	5.36	1.58	14.49	....	....	0.77
Old Colony	....	...	.....	....	.....	.. ....	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....
Philadelphia & Reading	....	....	487,076	304,962	927,965	1,720,003	....	....	....	....	....	....	74.90	....	. ..	4.62	4.55	0.36	..	5.86	0.42	15.81	....	....	....
Southern Pacific, Pacific System	730	670	684,758	843,763	291,571	1,820,092	2,717	5.51	14.11	...	...	....	64.83	....	....	4.96	16.81	0.22	2.25	7.28	1.13	32.65	....	.	5.22
Union Pacific	1029	..	659,693	1,076,102	355,072	2,090,867	2,032	6.07	17.32	...	...	. ..	90.01	....	....	6.57	8.65	0.21	0.97	8.10	1.24	25.74	3.90	1.84	1.91
Wabash	426	370	443,950	632,794	265,849	1,342,593	3,628	5.09	16.52	63.33	95.65	52.04	76.36	12.43	5.78	3.67	4.42	0.31	....	6.23	0.89	15.52	2.65	1.07	1.26
Wisconsin Central	150	112	127,900	191,355	60,799	380,054	3,393	....	....	....	....	....	71.55	....	....	2.50	8.46	0.21	....	7.22	....	18.39	....	....	2.32

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

St. Louis, Mo., September 12.—A switch engine exploded its boiler about 8 o'clock this morning in the Air Line yards, fatally scalding the engineer, Louis Laux, and Fireman James Smith.

Chicago, Ill., September 12.—Twenty masked men held up a Lake Shore train 150 miles from Chicago near midnight last night. After wounding the engineer, they blew open the safe of the express car. The engineer divined their motive, and grasping his coal pick, made a desperate resistance. One of the robbers was struck down and fell off the engine without a groan. Another came over the tender and in the dim light shot the engineer in the chest, seriously wounding him.

Philadelphia, Pa., September 13.—At noon to-day an outbound express train on the Philadelphia & Reading Railroad crushed into a shifting engine at Tenth and Diamond streets, killing Frank Peters, the fireman.

Wheeling, W. Va., September 14.—A Baltimore & Ohio freight train was wrecked at Dillon's Falls, a few miles west of Zanesville, this afternoon. It was caused by a loose rail which had not been properly spiked down. The freight train was coming east at a fast rate when the bad rail derailed the engine, which was overturned, and 14 freight cars piled upon it. Engineer Fisher was instantly killed.

Minneapolis, Minn., September 16.—The engine and 14 cars of the first section of the east-bound freight train on the Chicago, Milwaukee & St. Paul Railway was derailed at an open switch at Olivia this evening. Engineer George W. Remsen and Fireman Charles Heddings were instantly killed.

Buffalo, N. Y., September 17.—Daniel Ryder, an engineer of a freight train of the New York Central & Hudson River Railroad, while backing his engine up to a water tank at Black Rock this afternoon was severely injured. He had his head out of the cab window, and it struck the water-tank.

Columbus, Ga., September 18.—Fireman George Wright was killed in a wreck on the Mobile & Girard Railroad, 1½ miles west of Troy, this afternoon. The engine and four cars, for some unknown reason, were thrown from the track. The engine turned over and fell upon the fireman. The engineer was stunned, and lay unconscious for some time.

Cumberland, Md., September 18.—William Shoemaker, a fireman on the Baltimore & Ohio yard engine, slipped from his engine to-day and sustained a fracture of the arm.

Bath, Me., September 18.—Al. Leavitt, an engineer on the Maine Central Railroad, had his face severely scalded by escaping steam to-day.

Newburg, N. Y., September 20.—The night train on the Lehigh & Hudson River Railroad was wrecked at Lake Grinnell this morning by running into a freight train. The freight train was run on a siding, but being a long one, its head end stood out on the main track. There were lights out but no flag, and the express train ran into it while running at the rate of 40 miles an hour. Seeley Weeden, the engineer of the express, jumped, and landing in the lake, was only slightly hurt. The fireman, Joe Dunn, was carried into the wreck and buried under some coal. He is very badly injured.

Nashville, Tenn., September 21.—A train on the Newport News & Mississippi Valley Railroad was held up at Fulton, Ky., this morning, by robbers. The engineer and fireman are reported as being killed.

Chicago, Ill., September 22.—About 1 o'clock this morning, Edward Polack, a fireman on the Alley Elevated Railroad, was told by his engineer to look out for some obstruction ahead. As the latter put his head out of the cab window he was struck by a passenger train. The entire scalp was torn off.

Kingsbury, Ind., September 22.—A freight train of the Wabash Railroad was side tracked here to allow two sections of the Montreal express to pass. The first section passed all right, when the brakeman on the freight train opened the switch, supposing his train was to go out on the main track again. Just at this moment the second section, running at 55 miles an hour, came along, and before the switch could be closed dashed through it and into the freight train. J. Green, engineer of the passenger train, was killed. The fireman of the passenger train had a leg broken and was severely burned. H. J. Vatkeney, the fireman of the freight train, was burned and scalded about the head, and bruised. John Whitaman, engineer of the freight train, had his right arm broken, and was badly burned.

Birmingham, Ala., September 22.—At 1 o'clock this morning, 19 miles north of this place, an attempt was made to wreck an express on the Queen & Crescent route, by removing a rail from the track. The engine, baggage car and mail car were demolished. Engineer Frawley and Fireman Waite were hurt, but not fatally.

Cumberland, Wis., September 23.—A rear-end collision occurred between two freight trains on the Chicago, St. Paul, Minneapolis & Omaha Railroad near this city this evening, in which Robert J. Orr, a fireman on the rear train, was fatally hurt. He jumped into the darkness just before the collision, striking on a bridge and cutting his head open. The engineer jumped, but was not seriously hurt.

Jessup, Ga., September 25.—A runaway engine on the Sea vannah, Florida & Western Railroad, starting from this plac toward Waycross, ran into a freight train at the 63-mile post to-day. Both engines and several freight cars were wrecked, and the fireman of the freight train was seriously injured.

Wilmington, Del., September 26.—A boiler of a locomotive on the Philadelphia, Wilmington & Baltimore Railroad exploded to day, severely scalding Engineer Richard Beck and Fireman Samuel Alexander. The explosion occurred by the dropping of the crown sheet.

Bellevue, Mich., September 27.—An express train on the Grand Trunk Railroad, while standing at this station at 2 o'clock this morning, was run into by the Erie express. Fireman Jennison, of the Erie express, was badly scalded.

New London, Conn., September 27.—An engineer on the consolidated Road ran off the draw at Shaw's Cove this afternoon. The engineer failed to notice that the derailing switch was set against him. The track is laid on a trestle across the cove, and the derailing switch is placed at the edge of the land foundation on a curve. Three men were in the cab at the time and made a scramble for that side farthest from the water. The engine landed on its side deep in the mud, with its tender half over the cab. The three men were badly bruised and cut.

Sedalia, Mo., September 27.—A passenger train on the Lexington Branch of the Missouri Pacific Railroad had a narrow escape from destruction by running off of a trestle 5 ft. high half a mile west of that point. Between the ties on the east end of the trestle some one had placed a tie so that it projected above the rail nearly 3 ft. The engine struck it and was derailed, rolling down an embankment 8 ft. high and landing on its side. Engineer Patrick O'Connor and Fireman W. H. Finnell were injured.

Gulf Port, Miss., September 28.—A passenger train on the New Orleans division of the Louisville & Nashville Railroad ran into an open switch at this point this morning. It was running at the rate of 45 miles an hour at the time. An investigation shows that the switch had been properly set and locked, but that the lock had been burned off with a large pine knot and thrown away. The engineer and fireman were dangerously injured.

Hillsdale, N. Y., September 28.—A milk train on the Harlem Road was wrecked at this point to-day. Just south of this point the rails had spread, and the train rolled down a 50-ft. embankment. Engineer Ackert and the fireman, Joseph Anderson, jumped from the engine in time to save their lives. The engineer was badly bruised about the body, and received a severe scalp wound. The fireman was slightly cut.

Louisville, Ky., September 28.—There was a collision between a passenger and freight train this evening on the Knoxville & Cumberland Gap Branch of the Louisville & Nashville Railroad, near Hazelpatch, Ky. The misunderstanding of an order by one of the train crew is given as the cause. A fireman named Ryan was killed, and an engineer named Pierce had his leg broken.

Streator, Ill., September 28.—Two freight trains collided on the Chicago, Burlington & Quincy Railroad about 3 miles north of this city. Engineer William Gribble was killed. It was a head-on collision, and both engines were badly wrecked.

Phillipsburg, N. J., September 30.—A flue burst on an engine on the New Jersey Central Railroad about 6 o'clock this morning, filling the cab with steam, scalding the face and neck and upper part of the body of Joseph Lutz, the engineer, in a frightful manner. He is, however, expected to recover.

Our report for September, it will be seen, includes 40 accidents, in which 13 engineers and 14 firemen were killed, and 21 engineers and 19 firemen were injured. The causes of the accident may be classified as follows:

Boiler explosions	2
Broken connecting-rod	1
Broken eccentric rod	1
Bursting of flue	1
Collisions	16
Derailments	8
Falling from engine	2
Loose rail	1
Misplaced switch	1
Rail spread	1
Ran over derailing switch	1
Runaway engine	1
Shot by train robbers	2
Struck by obstruction	1

Struck by passing train	2
Train wrecked	3
Unknown	1
Total	39

TESTS OF THE NEW YORK AND WESTINGHOUSE AIR-BRAKE PUMPS.

Editor of the AMERICAN ENGINEER:

OUR attention has been drawn to a circular issued by the Westinghouse Air-Brake Company, called "A Comparative Test of the Westinghouse Air-Brake Company's 9½ in. Air Pump and the New York Air-Brake Company's No. 2 Duplex Air Pump." It is so at variance with actual results universally obtained with our duplex pump, that we repeated the tests under the same conditions, measuring the air, with three reservoirs, in the same way. The results of the tests were as follows:

NAME OF PUMP AND SIZE.	DUTY required to raise the pressure from atmospheric pressure to 85 pounds per square inch in one cubic foot of space, pumps working against a constant pressure of 90 pounds per square inch in main reservoir; steam pressure 140 pounds per square inch.		Piston Travel in Feet, per Minute.
	Time per Cubic Foot of Air.	Steam per Cubic Foot of Air.	
The New York Air Brake Company's No. 3 duplex pump, two steam cylinders 7 in. diameter and two air cylinders, one 10 in. diameter and one 7 in. diameter	7.174 seconds.	1.881 lbs.	174
The Westinghouse Air-Brake Company's 9½ in. air pump. One steam and one air cylinder, each 9½ in. diameter	9.799 seconds.	2.774 lbs.	108.3

The test proves the New York duplex pump delivers 34 per cent. more air per minute than the Westinghouse 9½ in. pump. It also shows that the New York duplex pump delivers 46 per cent. more air with the same amount of steam. This is in accordance with the results which should be expected from the principle of construction of the duplex pump. The capacity of the two air cylinders is 50 per cent. greater than the capacity of the two steam cylinders. *Both air cylinders are filled with free air every stroke,* and this is delivered to the reservoir. The efficiency must, therefore, be 50 per cent. greater than is possible with the Westinghouse pump, as that can only receive one measure of air for one measure of steam.

If any different results have been secured with the New York duplex pump, it is because the pump was *out of order.*

The amount of heat developed in compressing air is in proportion to the rapidity of compression. A higher temperature might therefore be expected from a pump that compresses 34 per cent. more air in a given time. Our duplex pump was designed for a special purpose—namely, to furnish air for operating air brakes. In this service it is utterly impossible to generate sufficient heat to impair the efficiency of the pump.

Yours truly,

THE NEW YORK AIR BRAKE COMPANY.

PROCEEDINGS OF SOCIETIES.

Montana Society of Civil Engineers.—The regular monthly meeting of the Montana Society of Civil Engineers was held Saturday evening, October 14. Mr. Joseph H. Harper, of Butte, read a paper on the Butte smoke problem. Mr. Harper proposes to construct two main flues to convey the smoke and sulphur fumes to stacks, one located about two miles southwest and the other three miles northeast of the city. The cost of these flues and stacks would not exceed $500,000. Mr. Harper exhibited photographs of flues recently constructed by the Omaha and Grant Smelting & Refining Company, at Denver, in which porous terra-cotta lumber was used for the covering of the flue under what is known as the Lee patent. Mr. Harper believes that if these flues were constructed the smoke nuisance would be almost entirely abated.

American Society of Electrical Engineers.—In the October issue of the *Transactions of the Society* there is an article by Ralph W. Pope, on the advisibility of holding the monthly meeting at points scattered throughout the country rather than at the New York headquarters. The monthly meetings of the Association have been very successful and largely attended, and for several years there has been an increase of attendance. The plans which are followed by the American Society of Mechanical Engineers and other associations holding their meetings at different points throughout the country are cited, and it is now proposed that the country should be divided into sections, holding these meetings at different points. The article discusses the matter from all standpoints, and provides for matters of finance and the methods of work where it would be impossible for the writer of the papers, etc., to be present at the meeting. There is no indication as to whether the idea will be consummated or not.

Engineers' Club of Cincinnati.—At the September meeting Colonel Latham Anderson read a paper under the title Telford *versus* Macadam—Which was Right? which discussed the question of the best method of constructing broken-stone roadways. The essential features of a roadway of this kind, he said, were an unyielding foundation, thorough surface and under drainage, hard, tough stone for wearing surface, proper size of stone, and the thorough compacting of the materials. The paper discussed two of these requirements—the foundation and the covering—as contained in the practice of Telford and Macadam. The most important thing in connection with the foundation was the proper and thorough drainage of the subsoil by lines of tile drains 2½ to 3 in. in diameter, more or less in number according to the width of the roadway to be built, completely carrying off all the water and rendering the soil at all times dry and hard. A foundation of broken stone 10 in. deep on such a bed would carry the heaviest load that could come upon it in ordinary practice. The stone for the top surface should be clean, crushed in a mechanical crusher, and screened in a revolving cylindrical screen through holes of ¼ in., ½ in. and 2 in. sizes, the dirt and dust being rejected. The sub-grade should first be covered with a layer of 2½ to 3 in. of screened gravel. On this is spread and lightly rolled 6 in. of the coarser sizes of the stone, and on this the fine layer is spread and thoroughly rolled about 2½ in. in thickness. A moderate amount of sprinkling assists in consolidating the materials.

New York Railroad Club.—The October meeting was held on the evening of Thursday, the 19th, and the feature of the evening was a paper by Mr. D. L. Barnes, on The Construction and Inspection of Locomotive Boilers to Prevent Explosions. It was profusely illustrated by stereopticon views showing the various methods of staying and bracing, with the author's ideas of the proper methods to be employed. There were also numerous illustrations of exploded boilers, showing the effects of the sudden rupture. The author's idea of the probable cause of the disastrous effects of the boiler explosion is that the sudden lowering of the pressure due to rupture caused a large quantity of the water which was contained in the boiler to flash out steam and to be hurled violently against the side of the sheets and tubes. Of course there was no new theory advanced of boiler explosions beyond that the boiler was not strong enough to stand the internal pressure. He stated that the majority of locomotive boiler explosions was undoubtedly due to the overheating of the sheets as the result of low water. He advocated the use of a double welt butt seam for all horizontal seams of the shell, and condemned the practice of having stay-bolt threads in contact at the bottom of the threads. The paper concluded with a classification of boilers into three categories, which would indicate their probable condition, and also with rules for the proper inspection of the various classes. The paper was somewhat lengthy, and it was decided that the discussion should be postponed until the November meeting.

Engineers' Club of St. Louis.—The Club met at 8 P.M., on October 4, at the Club rooms, 19 members present.

Mr. E. A. Hermann read the paper of the evening on Bracing a Tunnel in Soft Material. A tunnel 1,435 ft. long was built at North Bend, O., near Cincinnati, about 1840, for the Cincinnati & Whitewater Canal. The material encountered was a mixture of river sediments containing considerable water, and causing some difficulties in construction. About 1863 the canal was abandoned, and the right of way purchased by the Cincinnati & Indianapolis Railroad, now a part of the Big Four system. In March, 1884, an extraordinary flood in the Ohio River nearly filled this tunnel with water, and after

it receded a short piece of the tunnel about 80 ft. long showed a deformation of its section, the side walls being slightly pressed in and the arch flattened, and this deformation threatened to increase. The difficulty was promptly remedied by the system of bracing shown on the drawings. No further movement of the walls of the tunnel took place after they were braced for the following three years, when the extension of the double track over this part of the railroad necessitated either an enlargement of the tunnel or a realignment of the railroad around it. The latter plan was adopted as the cheapest and most satisfactory of the two, and after its completion the track through the tunnel was abandoned. Discussion followed.

Mr. George S. Morison presented to the club a valuable report on the Nebraska City Bridge. Mr. Brauer presented drillings of the nickel armor plate. For the next meeting a paper by Mr. D. A. Moliter on Landslides was announced.

Engineers' Society of Western Pennsylvania.—A regular meeting of the Society was held in Pittsburgh on September 19. Forty-one members were present; six applicants were elected to membership. The Library Committee reported the addition of 67 volumes since its last report. The papers read at the June meeting on Gas and Gas Producers, by Walter E. Koch, and on The Effect of Suddenly Applied Loads upon the Tensile Strength and other Properties of Iron and Steel were fully discussed. Mr. Charles Hyde gave an interesting discussion on Water-Tube Safety Boilers, illustrating his remarks by a working model of the Hyde water-tube safety boiler. On September 22 and 23 the visiting French Engineers were entertained by the Society. On the 22d they were taken by railway to the Macdonald oil and gas field, and to the coal-mines of the Pittsburgh Consolidated Coal Company; on the 23d by steamboat to Homestead, McKeesport, and Davis Island Dam. Very many of the largest and most important steel works, electric plants, inclines, and street-car power-houses were also visited. On the evening of the 23d the members of the committees of the Engineers' Society and of the manufacturers of the city were the guests of the French Engineers at a dinner at the Monongahela House.

A MEETING of the Chemical Section was held on September 26, 1893. The subject of Standard Methods for Sampling and Analysis of Iron and Steel was discussed. Mr. James O. Handy read a paper on The Effect of Arsenic on Phosphorus Determinating in Iron and Steel.

Engineering Association of the South.—At the meeting of the Association, in Nashville, Tenn., September 14, Mr. W. G. Williamson discussed the relations between the City Council, the Board of Public Works, and the City Engineer; he concluded that in small cities the existence of both the Council and the Board causes needless complications, though in large cities the great amount of improvements makes the Board more efficient than a committee of the Council; that the Engineer should be appointed by the Board, but should not be embarrassed by their appointing any assistants; that orders to the Engineer should proceed from but one authority, and if these orders are contrary to the Engineer's judgment, he should be allowed to put his objections on record; and that it is not good economy to bind an Engineer to let work to the lowest bidder.

Mr. Walter G. Kirkpatrick's paper described a System of Triangulation for River Surveying. The field work consists of reading four angles at each of a series of stations on one river bank, the distance between the first two stations and that between the last two being measured with tape. The computation is simple, a connected series of *sine* proportions, so that the addition of logarithms is cumulative, each addition evolving the length of a line in the system. The platting is by chords, affording such a check that an error can hardly escape detection. The system is accurate and requires but little more work than the ordinary transit and stadia survey; the computation can be framed from the field notes, then all the logarithms taken from a table, then all the additions made and all the necessary sides evolved, with which the plotting proceeds in a connected chain.

Mr. J. S. Walker discussed the Roof Trusses in the World's Fair Buildings. Mr. Hunter McDonald described the methods and progress in sinking caissons 40 ft. under water, for the foundations of the Johnsonville bridge over the Tennessee River now under construction.

Society of Naval Architects and Marine Engineers.—A notice has been sent out from the office of the Secretary-Treasurer in Washington, that the first general meeting of this Association will be held in New York City at 10 A.M., November 16, at the rooms of the American Society of Mechanical Engineers, No. 12 West Thirty-first Street, and that the session will extend through Thursday and Friday, November 16 and 17. It is proposed that there shall be an inaugural banquet on Thursday evening. An earnest request is made that the inaugural meeting of the Society be fully attended in order that the papers presented may be discussed with a thoroughness commensurate with their importance. Certificates of membership have been engraved, and it is expected that they will be presented to the members before they meet. Among the papers are the following: Transatlantic Navigation, by Charles H. Cramp, President of William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa.; Steel Ships of the United States Navy, by Theodore D. Wilson, ex-Chief Constructor, U. S. N.; The Development of Shipbuilding on the Great Lakes, by John F. Pankhurst, Vice-President and General Manager of the Globe Iron Works, Cleveland, O.; Notes on the Machinery of the New Vessels of the United States Navy, by George W. Melville, Engineer-in-Chief, U. S. N.; Coal Bunkers and Coaling Ships, by Albert P. Niblack, Lieutenant, U. S. N.; Production in the United States of Heavy Steel Engine, Gun, and Armor Forgings, by Russell W. Davenport, Vice-President of Bethlehem Iron Company, South Bethlehem, Pa; Determination of the Approximate Dimensions of a Vessel to Fulfill a Given Programme of Requirements, by Joseph J. Woodward, Naval Constructor, U. S. N.; Comparative Performances of American and Foreign Freighting Ships—Our Superiority, by William W. Bates, late Commissioner of Navigation, Treasury Department; The Wetted Surface of Ships, by David W. Taylor, Naval Constructor, U. S. N.: The Influence of Speed and Weight of Machinery on the Determination of the other Elements of the Design of Steam Vessels, by John J. O'Neill, Naval Architect and Marine Engineer; United States Treasury Rules for the Inspection of Machinery and Boilers, by James T. Boyd, General Manager George F. Blake Manufacturing Company. Papers are also expected from the following gentlemen, but the exact titles have not been decided upon: Colonel Edwin A. Stevens, President of Hoboken Ferries; A. Cass Canfield, Member America's Cup Committee, New York Yacht Club; Joseph H. Linnard, Naval Constructor, U. S. N.

PERSONALS.

MR. THEODORE NICKERSON, who has filled the position of General Purchasing Agent of the Mexican Central Railway for many years, having resigned to attend to his personal interests, Mr. E. W. BAKER has been appointed Purchasing Agent, with headquarters at Mason Building, Boston.

MR. JOHN D. FOUQUET, Architect for the New York Central and West Shore railroads for the past 10 years, has withdrawn his services from these companies, and will hereafter practise at 35 Broadway, New York, making a specialty of railroad structures.

Manufactures.

General Notes.

Manchester Ship Canal.—It is announced that it is the expectation of the management of the Manchester Ship Canal to open it for traffic throughout its entire length by January, 1894.

The Baldwin Locomotive Works have received an order for 10 Vauclain compound locomotives for the Philadelphia, Reading & New England Railroad. Of these, seven are Consolidation freight locomotives, with high-pressure cylinders 13½ in. × 24 in., low-pressure cylinders 23 in. × 24 in., driving wheels 50 in. in diameter. They will weigh in working order about 128,000 lbs. The other three are passenger locomotives, with high pressure cylinders 12 in. × 24 in., low-pressure cylinders 20 in. × 24 in., and driving-wheels 68 in. in diameter; estimated weight in working order about 96,000 lbs.

SUMMARY OF REPORTS OF DETENTIONS TO TRAINS FROM DEFECTIVE MACHINERY,

Fiscal Year ended June 30, 1893.

Cause.	Total.	Div. A.	Div. B.	Div. C.	Div. D.	Div. E.	Div. F.	Div. G.	Div. H.	Div. I.	Div. J.	Div. K.
Air hose bursting and becoming disconnected	14	5	2	0	0	2	1	0	4	0	0	0
" pipe breaking	12	0	4	0	1	1	0	0	1	3	1	1
" pumps failing to work	53	9	22	0	1	2	1	6	5	4	3	0
" signal breaking	4	0	0	0	0	0	0	0	0	4	0	0
Crank-pins breaking	22	1	2	2	0	0	3	0	9	1	4	0
Cross-heads breaking	6	0	0	1	0	1	0	0	1	2	0	1
Cross-head gibs and bolts breaking	66	5	4	15	0	2	15	6	11	2	3	3
Cylinders breaking	6	0	0	0	0	2	0	2	0	1	1	0
Cylinder cocks breaking	2	0	1	0	0	0	0	1	0	0	0	0
" heads "	29	4	5	1	0	2	0	1	1	3	11	1
Driving axles "	22	0	2	2	0	2	1	6	6	3	0	0
" boxes "	4	0	0	1	0	0	0	0	0	0	2	1
" brakes and bolts breaking	5	0	0	0	0	0	0	0	3	1	0	1
" springs breaking	21	3	7	2	0	0	1	2	3	2	1	0
Eccentrics breaking	19	0	0	3	0	1	1	2	4	4	3	1
Eccentric bolts breaking	57	2	4	5	3	1	10	8	5	8	9	2
" rods "	24	0	3	1	0	2	4	1	7	3	1	2
" straps "	34	2	3	3	0	6	2	1	9	4	3	1
Engine truck axles breaking	4	0	1	0	0	1	0	0	0	0	1	1
" " springs breaking	12	1	0	2	1	1	3	0	0	1	3	0
Follower head bolts breaking	6	0	0	2	0	1	0	1	1	0	0	1
Frame breaking	24	3	2	5	4	3	2	1	0	0	2	2
Grate arrangements breaking	108	4	12	28	8	7	13	3	15	9	7	2
Guides breaking	5	0	2	0	0	0	1	1	1	0	0	0
Guide bolts and nuts breaking	20	0	5	2	0	0	3	2	6	0	2	0
" yokes breaking	2	1	0	0	0	0	0	0	1	0	0	0
Jenney couplers breaking	2	0	1	0	0	0	0	0	0	1	0	0
Lifting-shaft arms "	4	0	0	0	0	1	1	0	2	0	0	0
Link breaking	1	0	0	0	0	0	0	0	0	1	0	0
" hangers breaking	2	0	0	1	0	0	0	0	0	0	1	0
Main rods breaking	4	0	1	0	0	0	1	0	1	0	1	0
" rod gibs and keys breaking	8	2	0	0	0	0	2	0	3	0	1	0
" " straps breaking	36	2	5	4	2	0	7	4	5	5	0	2
" " strap bolts breaking	11	0	2	1	0	1	0	1	4	2	0	0
Packing rings breaking	13	2	1	0	1	0	0	1	2	3	0	3
Piston glands "	5	0	1	1	0	0	0	1	1	0	1	0
" gland studs breaking	33	0	1	6	0	2	3	2	2	4	9	4
" heads breaking	8	0	0	0	0	0	0	2	1	0	3	2
" keys "	15	0	3	1	1	0	0	2	2	2	3	1
" rods "	41	3	0	1	0	4	2	3	12	7	9	0
Pop valve studs breaking	3	0	1	0	0	0	0	1	0	0	0	1
Pulling bars and bolts breaking	12	3	2	0	0	0	3	1	1	1	0	1
Rocker arms " " "	14	0	0	1	0	0	3	2	3	2	3	0
" box breaking	1	0	0	1	0	0	0	0	0	0	0	0
Safety valves "	12	1	0	1	0	0	1	2	4	1	2	0
Side rods breaking	7	2	0	0	0	2	0	0	1	2	0	0
" rod steady pin breaking	1	0	0	0	1	0	0	0	0	0	0	0
" " straps breaking	12	1	1	0	0	0	2	2	2	2	0	2
" " strap bolts breaking	10	0	1	3	0	1	1	2	2	0	0	0
Spring hangers and bolts breaking	116	9	15	13	2	19	19	6	11	7	9	6
" rigging breaking	69	6	12	5	2	2	14	3	17	3	4	1
Steam chests bursting	37	5	5	1	0	1	1	0	7	4	13	0
" chest relief valves breaking	6	0	2	0	0	0	0	0	1	1	1	1
Tender castings breaking	6	1	1	0	0	1	0	0	3	0	0	0
" draft rods "	8	0	1	3	1	0	1	0	1	0	0	1
" truck axles breaking	3	0	0	2	0	0	0	0	0	0	0	1
" " springs "	3	0	1	0	0	0	0	0	1	0	1	0
Throttle packing blowing out	7	3	0	0	0	0	3	0	0	0	1	0
" rigging breaking	4	1	0	0	2	0	0	0	0	1	0	0
Tires breaking and coming loose	7	0	0	0	0	0	0	0	0	3	4	0
Tire bolts breaking	2	0	0	0	0	0	0	0	0	1	0	1
Valves breaking	4	0	0	1	0	0	0	1	0	0	1	1
Valve stems breaking	5	0	1	0	0	0	0	1	1	2	0	0
" yokes "	9	0	3	0	0	0	4	0	0	2	0	0
Water scoops breaking	2	2	0	0	0	0	0	0	0	0	0	0
Wheel centers "	5	1	0	1	0	0	0	2	0	0	1	0
" guards and bolts breaking	3	0	2	0	0	1	0	0	0	0	0	0
Whistles breaking	4	0	1	1	1	0	0	0	0	1	0	0
Miscellaneous	127	7	7	14	11	9	12	10	32	9	13	3
Totals	1,263	91	152	137	42	81	141	93	215	122	138	51

The Stow Manufacturing Company, of Binghamton, N. Y., inventors and manufacturers of the Stow Flexible Shaft, report that their trade up to October 1 shows an increase over that of the corresponding months of 1892. Considering the general depression, this perhaps should be satisfactory to them; but their expectation of doing 100 per cent more business in 1893 than in any preceding year will hardly be realized. During the past two months they have greatly improved their plant, adding largely to their boiler capacity, etc. They report a decided improvement in the October sales over that of the preceding month.

Edwin Harrington, Son & Company, Incorporated.—The partners in the old firm of Edwin Harrington, Son & Company, manufacturers of machine tools in Philadelphia, announce that they have sold their interests and formed a corporation composed of Mr. John A. McGregor, formerly Assistant Superintendent of the Brown & Sharpe Manufacturing Company, of Providence, R. I.; H. S. Haskins, M H. Harrington and E. L. Harrington, of the firm of Edwin Harrington, Son & Company; M. J. Morrissey, Robert F. Scott and Roger Sherron, formerly with the above firm, and will continue the same under the name of Edwin Harrington, Son & Company, Incorporated, at North Fifteenth Street and Pennsylvania Avenue, Philadelphia.

Underground and Overhead Railways.—A comparison has been made between the earnings and expenses of the underground road in London and the elevated line in Liverpool, which seems to show that the elevated road is the better paying investment. It cost very much less than the underground road, while its earnings per train mile are greater and its expenses per train mile less. The expense of the underground road, which has now been in operation for three years, is 13 cents a mile, while the elevated, which has been running but six months, costs but 8 cents. Some modifications of this must be made, however, inasmuch as the underground road has one more car per train, but still the earnings of the elevated road per train mile are greater by nearly 4 cents. For the first six months of 1893 the underground paid a dividend of three-fourths of 1 per cent. per annum, and for the last three months five-eighths of 1 per cent. per annum. Previous to this no dividends were paid.

A FOUNDRY CRANE.

THE value of any hoisting apparatus for foundry or other fine work depends on its more or less perfect running. Thus, for the lifting of copes or molds the ordinary chain and sprocket wheel are almost useless. Made as carefully as possible, a chain running over a sprocket wheel will, as each link leaves its pocket, jar the load. The sand is liable to crack and the mold to break down.

With a view to obviate this difficulty, a new foundry crane has been designed by Edwin Harrington, Son & Company, Incorporated, of Philadelphia.

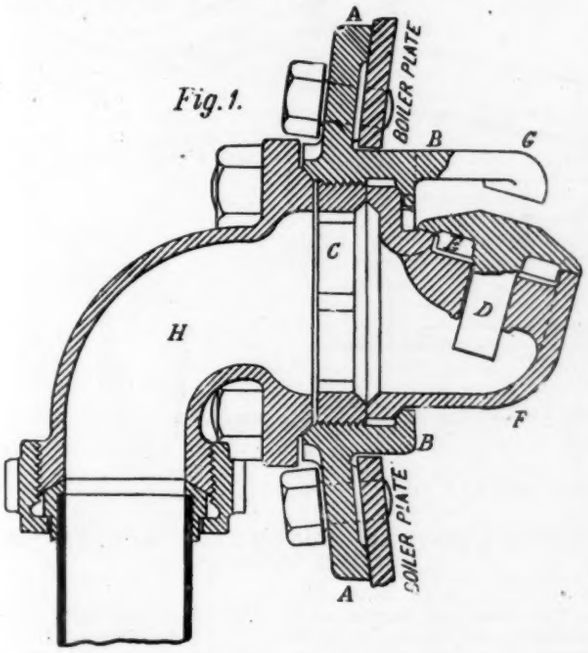
As will be seen by the engraving, the sprocket wheels of the hoist have been replaced by a drum having right and left spiral grooves, thus insuring the hanging of the hook always over the same point. There is no jumping or jarring; the movement is sure and steady, the chain winding and unwinding with the regularity of a rope on a windlass. Thus the cope can be lifted and lowered with no danger of the sand sifting out or mold "breaking down." The internal gears of this hoist are worked by means of a shaft extended far enough beyond the beams of the bridge to prevent the chain from interfering with the load, and this also enables the operator to stand at a respectful distance from a pot of melted iron.

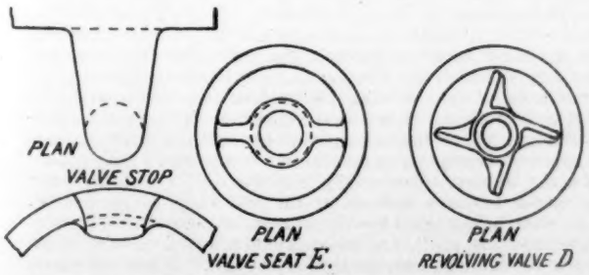
FOUNDRY CRANE, BUILT BY EDWIN HARRINGTON, SON & COMPANY, INCORPORATED.

The crane is operated by geared wheels throughout, and the shaft of the crane is placed inside the beam, thus saving room, and it moves the crane by pinions and intermediate gears, all of which are furnished with roller bearings, producing easy movement.

One of these cranes has been furnished to Messrs. Isaac A. Sheppard & Company, who have a foundry for the manufacture of stoves and hollow ware in Philadelphia. They say of it: "We are greatly pleased with the special foundry crane which you recently erected in our foundry. It is, in every way, perfectly adapted to the use for which it was intended, and lifts a mold absolutely without a jar, so that we have not had the least trouble with the breaking down of a mold at the critical point. For a light foundry crane we hardly see how it can be improved upon."

Fig. 1.





IMPROVED SAFETY CHECK VALVE.

THE FOSTER ENGINEERING COMPANY'S IMPROVED SAFETY CHECK VALVE.

THE illustration, fig. 1, herewith, represents a sectional view of an improved form of safety check valve which the Foster Engineering Company, of Newark, N. J., have recently brought out. Little description is needed to make its construction clear The valve is placed inside the boiler, the object being to place it out of danger or liability to injury in case of accident. In some of the most horrible accidents which have ever occurred on railroads, the injury to persons was largely due to the damage done to the check valves, which allowed the hot water in the boiler to escape, and which then scalded those exposed to it.

In the check illustrated, a ring, *A A*, is bolted to the boiler and surrounds the opening by which the check valve or its connecting pipe communicates with the inside of the boiler. This ring has a boss, *B B*, which extends inward through the opening in the boiler plate. The boss receives and holds a valve seat, *F*, which is inside of the boiler, and can be inserted or taken out through the opening in the ring *A A*. The seat is held in its place by a retaining ring, *C*, which is screwed into the outer ring. A valve, *D*, fits on the seat and can be removed with it. A stop, *G*, is attached to *B* and limits the movement of the valve. The feed pipe *F* is connected to *A A* by a neck, *H*, in the usual way. It is obvious that if this neck should be broken off that it would not disturb the check valve, *D*, and that if the water should escape from *F* the valve would close and hold the water in the boiler. In case of leakage the valve seat and valve can readily be removed and reground. Considerations of humanity should make the use of these valves or others equally effective compulsory on all locomotives.

THE MADDOX COTTON AND WIRE BELTING.

A NEW form of combination belting called the Maddox cotton and wire belting is now being introduced by H. N. Green, of 12 Wooster Street, New York. It is made of cabled soft steel wire and cotton woven solidly together, which makes it strong and durable. The cables of wire are each composed of six soft-steel wires twisted together like a cable, giving each separate one great strength. These cables are laid lengthwise in the belting about one-eighth of an inch apart, forming part of the warp, the cables composing about one-half of the warp; the rest of the belt being made of strong, tough cotton yarn specially spun for this work.

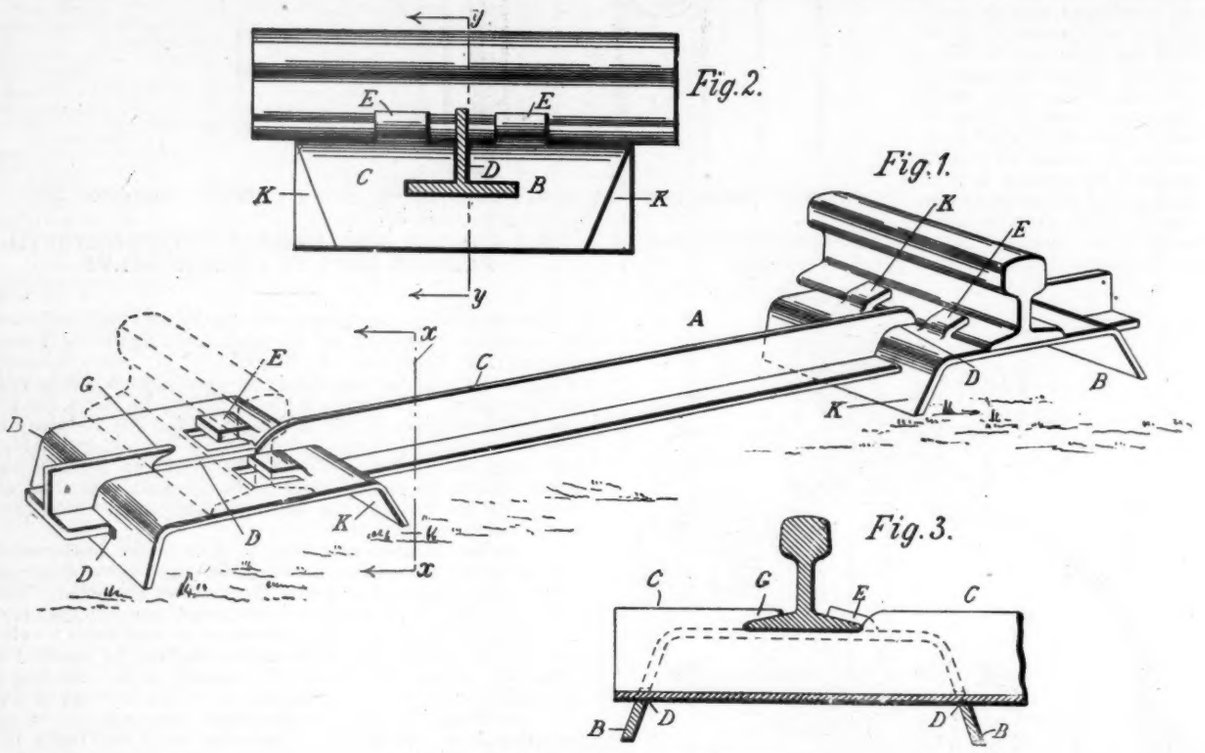
The cotton filling or woof is woven in solidly with the warp, there being no plies to pull apart. The process of weaving causes the wires to become corrugated in form with a depth about equal to the thickness of the belting. The belts are very flexible, and it is claimed that it is impossible for the

cables of wire to pull out. The weaving of the cotton and wire solidly together completely and thoroughly covers up the wires with the cotton, so that the wires do not come in contact with the pulleys at all, and cannot be seen in the belting except when it is cut so as to expose them. The rough surface given to the belting by the cotton forms an elastic face which prevents air cushions from forming between the belt and the pulley. It is claimed also that these belts can be run with greater amount of slack than ordinary leather belting, and that there is a consequent saving in wear and tear. It is waterproofed by being filled with a permanent water-proof material, and is said to be unaffected by water, steam, dampness, heat, moisture, dryness, oils, grease, acids or chemicals, or the vapors of any of them, changes of climate or water, dirt, dust, or other things which affect the ordinary run of belting. Furthermore, it will not rot, crack, mildew, or get hard and stiff, but always remain soft and flexible. It does not require grease, or oil, or other belt compositions. It is said to be especially valuable for use in paper and pulp mills, chemical works, oil and sugar refineries, oil and soap works, tanneries, bleacheries, cotton, woolen, and other textile mills.

same time this flange bears against the shoulder on the tie shown just below *E* in fig. 3, which prevents the rail from moving inward. The ballast is then tamped in under the sleepers. To facilitate this, their inner flanges are cut away so as to have an inclined form, as shown at *K K*, fig. 2. The rail then bears on top of the sleeper and rests on its top face and also on top of the tie at *D*, fig 1. The lips *G* on the tie and *E* on the sleeper prevent the rail from moving either outward or inward, and the ballast can then be very conveniently rammed under the sleepers and under the bottom flange of the tie-bar *C*.

All the parts, it will be seen, are made of wrought iron ; the ties are elastic in their nature, and from their form have an excellent support on the ballast. At the rail joints double ties are used so as to hold the rails more securely and give additional support to the sleepers.

The company named above, whose office is in the Betz Building, Philadelphia, propose to furnish these ties on long deferred payments, and think that they can show that it will be economical for railroad companies to substitute this form of permanent way for ordinary wooden ties.



THE COLUMBIAN METALLIC RAILWAY TIE.

THE COLUMBIAN METALLIC RAILWAY TIE.

THE American Railway Maintenance Syndicate of Philadelphia have brought out a new form of metal permanent way which they are now prepared to supply to railroad companies, and which is shown by our illustrations, of which fig. 1 is a perspective view, fig. 2 a side, and fig. 3 a sectional view.

The structure consists of first, inverted trough-shaped sleepers, *B*, which are made in short sections and are placed below and support the rails. These sleepers are held in their proper lateral position by angle-iron ties, *C*. The sleepers are made of the form shown, with sides which flare outwardly so as to give ample space below them to receive ballast and have sufficient bearing surface for the support of the loads they must carry.

The upper faces of the ties have lips, *E*, which are punched out of the metal and bent upward so as to receive the flange of the rail, as shown at *E* in fig. 3. The sides and top of the sleepers have openings in them of the form of the angle iron tie-bar, as shown by the shaded area at *D* in fig. 2 so as to receive this bar. The top of the bar is notched, as shown at *D*. fig. 1, and has a lip, *G*, which hooks over the outside flange of the rail. In laying the rails the sleepers *B* are moved inward far enough to permit the outside flange of the rail to be hooked under the lip, *G*. The sleeper is then moved outward, and the lips *E* engage with the inside flange of the rail. At the

ROWELL-POTTER AUTOMATIC SYSTEM OF BLOCK SIGNALS.

FOR some time past this system has been in successful operation on the Boston, Revere Beach & Lynn Railroad, for use as a safety stop device in the protection of switches and a tunnel. On May 20 last it was also put in operation on the Intramural Railway of the Chicago Fair as a permissive system, and on July 31 last the absolute blocking was adopted. The essential features of the device are that if an engine runs past a danger signal a valve in the train pipe is opened and the air brake applied. The means used to accomplish this are very simple indeed. At each station there are three bars lying close to the rails which are very similar to the ordinary detector bar, and whose distance apart depends upon the traffic and the speed of trains. The central bar is attached to the signal, and when the latter is at safety it is raised up so that it would be depressed by the passage of the first wheel of the engine. As this bar is depressed the signal is set at danger and remains at that position until it is released and allowed to drop by an electric connection from the station beyond. When the signal is set at danger the other bars are raised, and they are connected with a simple arrangement outside of the track by which a stem or rod dropping down from the outer end of the buffer of the locomotive comes in contact with it and is raised. As this rod is raised it opens the valve in the train pipe and

immediately applies the brakes. It is probably the most extensive system of automatic stopping of engines on the block system that has yet been adopted, and its action on the Intramural Railway seems to show that it is a success

There were 19 failures to operate on the Intramural Road during the time which it has been in operation, and taking this in comparison with the number of trains which have passed and number of movements which were necessary, it makes one in about 14,000 movements.

The device is being exploited by the Rowell-Potter Safety Stop Company, whose office is 117 Greene Street, Jersey City, N. J.

THE MANUFACTURING OF THE BOIES STEEL WHEEL.

THE Boies steel-tired wheel which is manufactured by the Boies Steel Wheel Company, of Scranton, Pa., presents some novelties in the method of its manufacture which will probably be of interest to our readers. A cross-section of the wheel is shown in fig. 1, and in this the center portion of the wheel is made of wrought iron with the steel tire shrunk on in position. It will be seen that there are only two parts to the wheel, and that the tire is thoroughly locked into and shrunk upon the center. The tendency of the rail against the flange is always to thrust the tire in toward the center of the track, and this is resisted in this case by the lip which projects up from the center and the one which comes down on the outside from the tire. The lock which is usually accomplished with a retaining ring is also used here, but is a part of the substance of the tire itself.

The method of manufacturing this center is exceedingly interesting. Selected scrap iron is first hammered down under a 15-ton hammer into round disks with a slightly increased thickness of hub at the center. Two of these disks are then raised to a welding heat and hammered together into the form of the center as it is used in the wheel. The heating is accomplished in a gas furnace, the gas being made on the premises by a special apparatus. Estimates of the expense show that for the same amount of work the expense of manufacturing the gas and using it as a fuel is but slightly in excess of what it would cost to use the coal direct, but that the results are very much better in cleaner and more substantial work. The hammering and forming of the center is done between dies, so that each wheel comes out practically perfect, and requires simply a turning off of the outer rim and a boring out of the hub before the tire is placed in position. The shrinkage which is allowed for the tire is of the regular master mechanic's standard of .01 of an inch to the foot in diameter. It will be seen that it is necessary to roll back the tire into the groove on the outside face of the center of the wheel; this is accomplished in the ordinary wheel lathe by a tool which is attached to the tool-post and is shown in fig. 2. The metal is spun down into the groove rather than being crowded or bent in. The tool consists of a roller held by a bar, which is in turn fastened in the tool-post of the wheel lathe, and the pressure which is brought to bear upon the overturned lip is that which can be obtained by drawing in on the screw of the cross feed of the tool carriage. It is possible to do this work in about 10 minutes, but owing to the desire to spin the metal out rather than bend it down, an hour is occupied in the work, the wheel making four revolutions to the minute. After this is done the tire is, of course, thoroughly locked in position, and when it becomes necessary to remove it the wheel is put in the lathe and this turned-down lip is cut off.

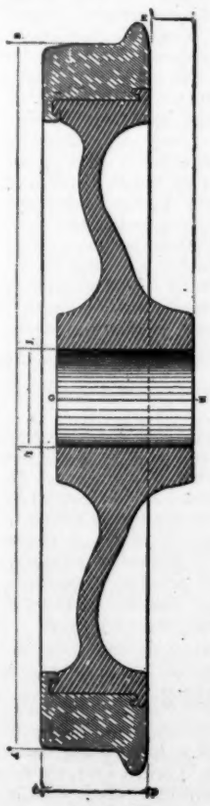


Fig. 1.

Experiments have been made with the rings which have been cut out of the metal, and they have shown that there is practically no change in the structure of the material in any way, and that it is fully as strong after being spun down into position as it was before that operation took place. The claim which is made for the wheel is that it uses the most suitable material in just the right place—that is, it has a soft wrought iron with fibers interlaced for the center and with steel tire for the tread.

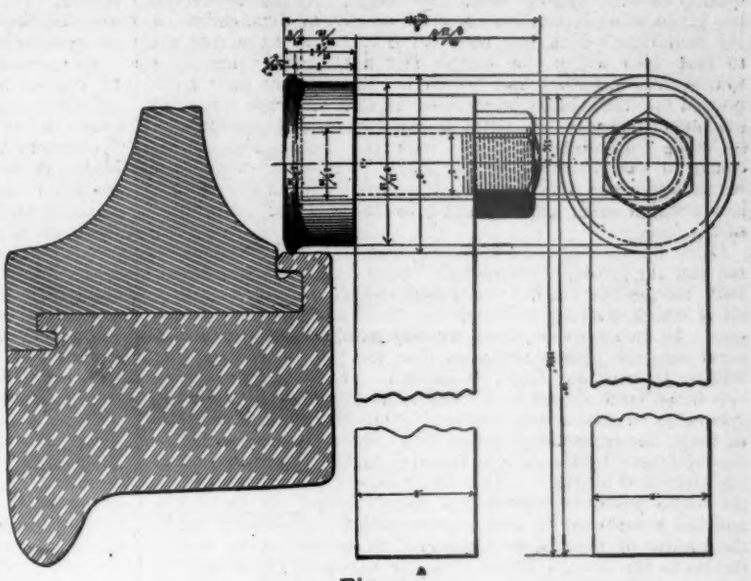


Fig. 2.

MANUFACTURING THE BOIES STEEL WHEEL.

Rifle for Canadian Volunteers.—The Martini-Metford rifle has been adopted as the future arm of the Canadian Volunteers. It is generally considered to be among the best of the single shooters, and to have some advantages over the magazine rifles chosen for the English Army. It has a small bore, and with so small a trajectory that it is fired point blank up to 500 yds.

The Tanite Company have sent us a box of their polishing paste for brass, nickel, zinc, and for the hot metal of fire and steam engines. As we do not run a steam engine in the office of the AMERICAN ENGINEER, we could not try it on such a machine. We are assured, though, that it will polish almost anything, from a brass kettle to the manners of a boor. It is said that it was tried on one of the latter who was in the habit of eating with his knife, picking his teeth at the dinner table, and chewing gum thereafter, and that now, owing to the effect of the tanite paste, he has abandoned all these bad habits and is a *polished* gentleman, who observes all the amenities of civilized life. We recommend our readers to try it on their steam engines if not on their friends who chew gum.

Wilmot & Hobbs' Oiler.—The Wilmot & Hobbs Manufacturing Company, of 20 Murray Street, New York, are making a copperized steel anti-rust oiler which is being received with a great deal of favor by engineers and others who have to do with the oiling of machinery. It is heavily copper plated inside, and is made of cold rolled No. 20 gauge steel. This steel has an exceedingly smooth surface, is rolled very accurately to the gauge, and is of uniform quality, free from scale and grit. The outside is so handsomely burnished that it perfectly resembles burnished copper. The sample railway oiler holds 2 quarts; it is 5 in. in diameter, 8 in. high, and is made from two seamless drawn parts. The nozzle is 1¼ in. in diameter at the base, and may be made as long as 24 in. There is also another kind made in pint and quart sizes with 18-in. nozzles. These are heavily nickel plated over the copper.

The Joseph Dixon Crucible Company have authorized the publication of the fact that one of their commercial tourists, by his presence of mind in a recent railroad accident, saved a well-known clergyman from serious injury. The reverend doctor is the authority for the statement that the Good Samaritan mentioned in Scripture was a drummer, who, he says, had the *best* of oil and wine. It is not quite clear on what evidence this exegesis is based. Scripture tells us that a "certain man fell among thieves in Jericho," who "left him half dead," and that a Samaritan, "as he journeyed," had compassion on

him and administered oil and wine, and brought him to an inn, paid his bill, and told the host to take care of him, and "whatsoever thou spendest more, when I come again I will repay thee." The parallel is obvious. The Good Samaritan had wine, so have most drummers—often they have very "high" wine. The reverend doctor says that the Good Samaritan's wine was of the *best*. St. Luke is silent on that point. Is there not, perhaps, a little confusion here? It is hardly probable that the doctor would give testimony with reference to the quality of wine without some knowledge. As the Evangelist has given us no intimation about the quality of the contents of the Samaritan's flask, our reverend friend must have referred to that with which the Joseph Dixon Crucible Company's tourist was supplied, and which he (the tourist) may have poured into the injured person's—wounds. There is collateral evidence bearing on this point in the fact that the doctor says he woke "up about midnight with the bottom side of his coach in the direction of the stars." Pouring wine into wounds sometimes has this effect, especially when the wound is one which never heals up and is in the front and lower part of the face.

Other parallels are the circumstances that both the Samaritan and the tourist "journeyed;" they were both acquainted with the host of the inn; they both expected to come again—all of which is strong evidence that the Samaritan was a drummer. In two respects, however, the parallels fail—the scriptural account plainly indicates that the host of the inn was willing to trust the Good Samaritan. Would most hosts in this broad land of ours be willing to do the same thing for the generality of commercial tourists? Our clergyman friend tells us that "the drummer of Jersey City had the best of pencils"—manufactured by the Joseph Dixon Crucible Company—"and the kindest of hearts." In the latter respect he and the Samaritan—who probably represented some "house" in Jerusalem and had a customer in Jericho—resembled each other; but in the matter of pencils, no "concern" in Jerusalem can hold a candle to the Joseph Dixon Crucible Company, to whom the judges at the World's Fair have made awards for superior products in graphite, lead-pencils, plumbago, crucibles, black-lead stoppers and nozzles, dippers, bowls, foundry facings and lubricating graphite.

We would, though, like *fuller* information about the relative quality of the Samaratian and Dixonian wine.

THE TANITE COMPANY'S EXHIBIT OF ABRASIVES AT THE CHICAGO EXHIBITION.

In Machinery Hall, at Chicago, several emery wheel makers have full and interesting exhibits of a commercial character. The Tanite Company, of Stroudsburg, Pa., was requested by the Exposition authorities to treat "Abrasives" from an educational standpoint. The exhibit here illustrated and described is the result, and its compact character is due to the fact that the exhibit will be presented as a gift to the Smithsonian, the Chicago University, or some other suitable institution. While some of the articles were furnished by the Tanite Company, many were contributed by liberal-minded manufacturers.

Emery, being the most important abrasive, is illustrated fully. Emery ore is shown from Turkey, Greece, and the United States. In one piece clear blue sapphire can be seen with the naked eye. On a platter of pure aluminum are shown sapphires, corundum and emery, with the explanation that alumina is the oxide of aluminum, and that the articles on the platter are largely composed of crystallized alumina, the sapphire being almost pure alumina. Emery is then shown in its successive stages—first, as it comes from the crusher; then in the form of grain and flour; then as polish (powder, liquid, and paste); and, lastly, in the shape of whetstones and solid emery wheels. Fragments of various classes of tanite wheels are displayed to show the internal texture. There are bottles containing the dust gathered under tanite wheels after the grinding of cast, malleable, and wrought iron, and of brass and steel. These are for experimental examination with magnifying glass and magnet. "Petrified sparks" are an interesting feature. These are strangely shaped cones formed of the matter which fuses below an emery wheel when grinding under heavy pressure. The comparative products of the emery wheel, file, and cold chisel are tabulated on a framed sheet, while the case contains pieces of cast iron and saw-steel with the cuts made by file and wheel. The piece of saw-plate demonstrates that in a given time the wheel did 126 times as much work as the file. In the case and on the ends of the stand are numerous parts of machines, all of which have been surfaced by the Newman Emery Planer. These appear to be as true as if planed, and tabulation shows that this machine has taken a maximum cut one-quarter of an inch deep, and has taken a $\frac{1}{16}$ in. cut over a surface of 100 sq. in. in 6 minutes and 9 seconds. Its ordinary cut is from $\frac{1}{64}$ to $\frac{1}{32}$ in.

Emery wheels are usually thought of in connection with metal grinding, but in this case are shown blanks for long combs and ladies' back combs, made of vulcanite, and other samples showing that the long comb has been edged and the back comb had the spaces between the teeth cut out with tanite wheels. Glass guides from a silk-spinning mill are also shown. In these guides the silken thread wears a tapering groove which eventually breaks the thread, and these grooves are ground out by the use of tanite wheels.

As curious and instructive examples of abrasion, the parts of various machines used in the Tanite Factory are shown, all testifying to unequal and destructive wear due to unequal stress and the friction of emery dust.

Corundum is shown from Ceylon and from our Southern States, in the form of mineral samples, and also in grain. To the latter samples, as also to some of the emery samples, are attached analyses showing the proportions of insoluble corundum, of dissolved alumina, etc. Samples of pumice stone and of rotten stone are contributed by T. Van Amringe, of New York. Baeder, Adamson & Company, Philadelphia, show rock flint, or quartz, and rock crystal garnet, in rock, in grain, and on cloth. Norris & Brother, Baltimore, exhibit India spar. B. C. & R. A. Tilghman, Philadelphia, show chilled iron shot. The Pittsburgh Crushed Steel Company show a full line of samples of their so-called steel emery, and the Carborundum Company show that material rough and finished. Mill stone rock is shown by W. & F. Livingston and by Samuel Carey, both of New York. William M. Kirby, Pittsburgh, shows grindstone rock, as do also J. Westby, Levick & Company, Sheffield, England. J. B. Hull, Stroudsburg, shows, in regular order, the materials used in rubbing down granite and marble. Scythe stones, rough and finished, are displayed in great variety by P. M. Peterson & Son, Porsgrund, Norway. The Pike Manufacturing Company, of New Hampshire, also show a great variety of natural whetstones, etc. D. A. Richardson, Helena, Mont., contributes rough sapphires, and A. W. & C. E. Tanner, Red Bluff, Mont., some fine specimens of garnet. Corundum is supplied to this exhibit by Edward L. Hand & Company, Philadelphia, and by George L. English & Company, New York. Among the curiosities of abrasion are the following: Leaves of the Afeen plant, used to clean gourds, after the manner of sandpaper; contributed by Bolding Bowser, Esq., U. S. Consul, Sierra Leone, Africa. Wood of *Agave Polyacantha*, used for razor strops, contributed by William P. Pierce, U. S. Consul, Trinidad. Dutch rushes, or scouring rush (*Equisetum Hyemale*), from Yorkshire, England, supplied by David Brodie, M.D, London; and rush for same purpose, furnished by John Selwood, Stroudsburg, Pa. The epidermis of these plants is formed of silica, and the rush is used to polish wood and metals. Shark skin is contributed by the Tanite Company. This is to be used in same way as emery cloth and sandpaper.

Samples of carbon, or black diamond, and also samples of clear or gem diamond, suitable for turning or dressing emery wheels, are shown by the Tanite Company. The evolution of razors and table knives is shown in two series of samples, beginning in each case with the rough ingot or blank of steel, progressing through various stages of polish to the final bright finish.

An interesting series of photographs shows emery veins and mining processes in Westchester County, N. Y.

Two pictures are also exhibited: one of these seems to represent the tail of a comet, though what is really shown is the stream of fiery sparks streaming off from a Tanite emery wheel while engaged in grinding through a file. The other is a photographic reproduction of a picture in the Royal Gallery, Berlin. The photograph was contributed by Markt & Company, Hamburg, and the painting was by Gerard Ter Borch, who was born in Holland in 1617. This painting represents with much detail "The Grinder's Family," and depicts clearly the rough and primitive grinding processes then employed.

WORLD'S FAIR ROUTE.

The C. H. & D. Railroad have issued a handsome panoramic view, 5 ft. long, of Chicago and the World's Fair, showing relative heights of the principal buildings, etc.; also a handsome photographic album of the World's Fair buildings, either of which will be sent to any address postpaid on receipt of 10 cents in stamps. Address D. G. Edwards, General Passenger Agent World's Fair Route, 200 West Fourth Street, Cincinnati, O.